

CHEMICAL & METALLURGICAL ENGINEERING

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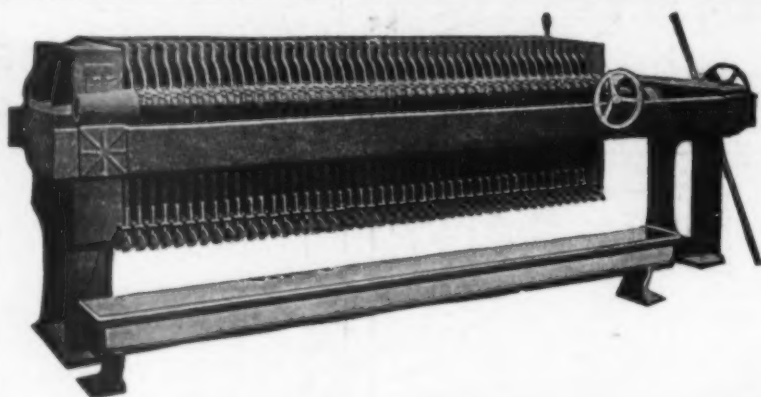
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Number 2

Now He's Bossing Dad

DOUBTLESS most of our readers and all of our metallurgical friends are acquainted with the *Iron Age*, so that no introductory remarks are necessary. To those of them who do not see it regularly, however, we take the liberty of reproducing the following copyrighted poem by L. G. FIRTH, of the Firth-Sterling Steel Co., which appeared in an ornamental border on one of its recent front covers:

"THE MAN AT THE FIRE"

There are some who forget what experience means,
(They are generally fellows just out of their 'teens)
And by using pyrometers seem to acquire

A lack of belief in—
"The man at the fire."

They'll talk of "calescence" and "pearlite," and tell
You the value of "cementite":—(sounds very well!)
And the depth of their learning will make you perspire,
But they don't get results, like—
"The man at the fire."

A pyrometer's good when it's kept in its place,
But sometimes you'll find there's a lie on its face,
And then when the heat's climbing higher and higher,
The man who can tell, is—
"The man at the fire."

Now do not mistake me; I say, by all means
While you're lacking in skill, put your trust in machines;
But if to be really expert you aspire,
Then study, as well, with—
"The man at the fire."

So when you are learning your job, never heed
Those who tell you that skill is a thing you don't need;
For skill and hard work you will surely require,
If you hope to compete with—
"The man at the fire."

The question immediately arises: Is this an advertisement, or is it not? On first glance, it certainly appears like editorial matter—no product or material is described or bulletined in it. It contains an idea which might readily be treated in this manner in editorial pages. Nevertheless we hasten to affirm our belief that it is an advertisement, unfortunately not censored.

Assume for the instant, however, that it is matter selected for display by the editors. On this assumption one cannot help but speculate what class of readers this poem would attract. It appears to be addressed to the unseasoned technical student, cautioning him against allowing a pyrometer to remain too long without calibration, of using technical terms beyond everyday parlance (although doctors appear to get rich doing just that), and of neglecting the human element involved in all manufacturing operations. These points should

always be borne in mind, although we would judge that the emphasis in the quotation is rather misplaced. It would be a rather safe bet that for every error due to inaccurate electric pyrometers there exist a dozen due to the "human-eye" pyrometer. As a matter of fact, scientific control devotes most of its energies toward preventing errors by "The Man at the Fire."

But we have been told that the *Iron Age* circulates mostly among executives, superintendents and purchasing agents. The small number of immature students seeing this cover would not warrant its use for them. If the editors deliberately address the big men in the industry in this tone, this outside cover appears as a direct slur on applied science; as a reflection of the attitude which rock-ribbed conservatism has always had toward progress. From a reasonable familiarity with the editorial pages of the *Iron Age* and an acquaintance with the editors themselves we therefore decline to believe that they are responsible for this cover. Even the reading pages of the same issue carry in the place of honor, crowding out such important business information as "The Metal Schedule in the New Tariff Bill," an article not by a man at the fire on "An Occurrence of Nitrogen in Steel." We are therefore forced to the conclusion that a certain steel company is willing to pay a considerable sum to advertise (a) that one of its officials is a poet, (b) that its products are still made in the good old-fashioned way, (c) that its steel is immune from any hardening-room abuse, or (d) that the man at the fire is the best judge of excellence in alloy steel.

Such an appeal for a return to the happy-go-lucky methods of rule of thumb displayed so prominently, even in advertising, cannot pass without protest. No thoughtful man but marvels at the heights of metallurgical perfection—oftentimes yet unimproved—reached purely by cut-and-try methods; by groping in the dark. But he also understands how painfully slow was this progress. Iron has been known since man can remember, yet a lingering two thousand years crawled by between the invention of the first crude blowing bellows and its equipment with a simple flap valve! Civilization progresses with ever-increasing speed, however. It took only a short hundred years to change the blast furnace from a machine producing twenty-five or thirty tons of pig iron a week to as much an hour. But are we going to throw away our pyrometers, our microscopes, our equilibrium diagrams, our calescences and cementites because "they don't get results, like—the man at the fire"? Is the man at the fire a good yardstick to measure an X-ray spectrometer?

After humbly courting a reluctant muse, we submit the following poem (with our humble apologies to CARL SANDBERG) as a counter-irritant. In order that there may be no doubt in the casual reader's mind about its

status, we hereby certify that it contains the germ of CHEMICAL & METALLURGICAL ENGINEERING'S editorial policy.

"NOW HE'S BOSSING DAD."

Bill Jones, he
Was a treater skilled. He
Knew just why he
Put manure into his quenching tub.
But one day,
Ann, Bill's wife,
Said,
"Bill, you're stuck in the mud.
Bill, Jr., goes to Tech."
So Jr. went
And saw
All manner of strange things
On a blackboard
In a microscope
In books;
Then he came home and got a job in the factory.
* * * * *

Now he's bossing Dad.

Progress in The Dye Industry

AMAZING progress was made in the dye industry during 1920. Notwithstanding that for the last three months of the year the majority of the plants were closed or operated on a greatly reduced scale, the industry had an output, according to the recent report of the Tariff Commission, of 88,000,000 pounds of finished products valued at more than \$95,000,000. This is a tremendous increase over the production during 1919 and is practically double the total pre-war imports. That our consuming industries are now almost entirely independent of foreign dyes is shown by the fact that the imports during 1920 amounted to less than one twenty-fifth of the domestic production.

The production of indigo is an example of real progressive development. Since 1917 our output of this important color has increased from 275,000 pounds to over 18,000,000. The latter figure is at least twice the domestic consumption before the war, and indigo has been able therefore to play an important part in our export trade in dyes and chemicals. This production exceeds that of sulphur black, which has previously been produced in largest quantity.

There is still, however, a noticeable lack of variety among the important vat dyes other than indigo. A considerable portion of the imports during 1920 was of these so-called "specialties," which just before the war were beginning to replace many of the older and less satisfactory colors. Some of these, to be sure, were produced in ample quantity, but many other dyes of this faster type have not yet made their appearance.

One particularly significant fact shown by the commission's report is that more than 90 per cent of the total quantity of dyes was produced by three or more manufacturers. This statement would seem to indicate that monopolistic control of particular products has not as yet made great headway in the domestic industry. Perhaps this will to some extent allay the fears of those members of Congress who have opposed the dye legislation on the ground that it is an attempt "to grant exclusive rights to a recognized monopoly."

The dye industry is to be congratulated on the showing it has made, and it is hoped that with the general resumption of business it will not only continue to expand its output but through research and development will produce a wider range of dyes of newer type and better quality.

Looking Forward To Fall Meetings

BY A HAPPY conjunction of events American chemists will have an unusual opportunity for professional intercourse during the last week of August and the first two weeks of September. The headliner on the bill is the British Society of Chemical Industry, which will hold its fall meeting in Canada, and the supporting features are successively the regular fall meeting of the American Chemical Society and the National Exposition of Chemical Industries in New York. British, Canadian and American chemists will mingle at all these functions, which will afford three weeks of opportunity for renewing old acquaintances, making new ones, and incidentally fortifying that bond of fellowship between English-speaking peoples which we are all convinced will be a large factor in the solution of many world problems.

Chemistry should gain fresh impetus in England, Canada and the United States as a result of the meetings that will be held in Montreal and New York. The science and its application to industry have assumed a position of new importance in England just as they have in this country, and while we are showing our visitors something of the efforts we have made to establish a chemical industry in the United States undoubtedly we can learn many lessons from the problems they have encountered and solved. The Exposition will enable us to show our guests concrete evidence of the progress that chemistry has made on this side of the Atlantic. It should prove not only a source of entertainment to them but also a stimulus toward the edification of chemistry in England. It is not too early to begin to plan for a visit to New York from September 6 to 10, when the American Chemical Society will be in session with the Society of Chemical Industry as visitors, or from September 12 to 17, when the Chemical Exposition will be held in the Eighth Coast Artillery Armory. It will be years before a similar opportunity is again afforded.

A.S.T.M. Unable To Join Federation

IT IS to be regretted that the American Society for Testing Materials finds itself unable to join with the Federated American Engineering Societies. An invitation to become a charter member was issued after the Federation had been organized, and has been carefully considered by the executive board of the A.S.T.M. during the intervening months. Action was finally reported and approved by the recent meeting at Asbury Park.

In view of the society's principal utility—which seems to be a medium whereby divergent views of buyer and seller of materials of engineering construction can be harmonized into acceptable specifications—it might be questioned whether such an organization would have interests identified with commerce rather than with engineering. Acquaintance with the personnel of the committees and active men in the society dispels this notion. Even though powerful organizations like the Steel Corporation and the Pennsylvania Railroad are vitally interested in specifications, they are represented almost exclusively by engineers or engineering chemists. Independent consultants and instructors are also much in evidence, and presidents, vice-presidents and salesmen rather scarce. The

result naturally is to inject a pronouncedly engineering rather than commercial atmosphere into committee meeting and general assembly.

Therefore it was not a surprising event when the American Society for Testing Materials was the first society to join the founders of Engineering Council, and its representatives did their share of the work of launching the Federation. But now, after a year's consideration, the executive committee finds that its budget will not be able to furnish the necessary funds for this new affiliation without serious curtailment of its current activities. In view of the present public temper, it was thought inadvisable to increase the dues, a decision which was sustained by the general meeting, despite a motion to refer the whole matter to a letter ballot of the membership.

Knowing the history of the two bodies, there seems to be no reason to doubt the sincerity of the official resolution indorsing unreservedly the belief that the "objects for which the Federation is organized merit the support of engineering organizations and engineers in general," and the further resolution offered from the floor that the present action was not to be construed to prevent affiliation at a later date, when the financial conditions and prospects of the society warranted the step.

Industrial Menace of Tax-Exempt Securities

WHILE the subject of political economy is admittedly outside the editorial scope of this magazine, the matter of taxation is of such vital import to the chemical and related industries that we may be pardoned for calling attention briefly to the McFadden resolution, H. J. Res. 102, pertaining to tax-exempt securities. Students of taxation have for some time been directing public attention to the menace of the continued issuance of tax-exempt securities by the Government and its political subdivisions. It has been estimated by OTTO H. KAHN that up to January, 1921, such securities have been issued to the value of \$14,425,000,000, of which half represents the debts of states, cities, school districts and other political subdivisions and the remainder the obligations of the Government. Obviously individuals of wealth have accumulated these securities as rapidly as possible to such an extent that they are rapidly freeing themselves of the burden of taxation, which is forced onto those less fortunate. The extent to which tax-exempt securities have been segregated in the hands of the wealthy and the consequent effect on the taxable income of individual taxpayers under the federal income tax may be seen in the fact that taxable income of \$992,972,985 in 1916 decreased to \$731,372,053 in 1917 and to \$392,247,329 in 1918.

The effect of Mr. McFADDEN'S resolution would be to amend the Constitution in such a manner as to place all forms of investment on an equitable basis of competition and to re-establish equality in the assumption of the tax burden by all the people. The former is of direct interest to the normal progress of industry and the latter is of personal interest to every federal tax payer. As nearly as we can ascertain competent opinion in the matter, legislation to abolish tax-exempt securities is highly desirable and we feel justified in bringing the matter to the attention of our readers with the suggestion that they take legitimate steps to encourage the passage of the McFadden resolution or similar legislation.

Steel Prices And Wages

THE American steel industry is displaying very plainly an anxious desire to play fair with its workmen and its customers. Steel prices have been declining. There having been at least two markets in 1920, the Steel Corporation holding its prices to the Industrial Board schedule of March 21, 1919, while the independents made large advances, the independent market has been declining for almost a twelvemonth, while the Steel Corporation's prices began their decline April 13 of this year. The decline has brought steel prices to a level between 50 and 60 per cent above the pre-war level, according as one takes as basis for comparison the ten years ended with 1913, the five years ended with 1913 or the average of 1913 alone.

The major portion of the steel-consuming trade has not desired that steel prices be cut ruthlessly. In most cases the manufacturing consumers have had stocks of steel or of their manufactures, made from steel, which they desired to liquidate. They wished to sell their goods, rather than buy steel, hence in many cases the steel mills would be rendering their customers a disservice by reducing prices. At the same time it was to the interest of the steel makers not to slash prices, as they would obtain little if any more business by doing so.

Last week the Bethlehem Steel Co., one of the most prominent of the independent producers, formally announced a schedule of price reductions, and the action was followed, formally or otherwise, by other independents, while a couple of days later the Steel Corporation made a formal announcement of the same tenor. To the layman it may have appeared that the steel market had been pegged at a certain point, that a new peg was inserted farther down and that the first peg was forthwith pulled out. That, however, was hardly the case. During the preceding week the open market had really sagged and the new prices were chiefly a formal recognition of prevailing prices.

The steel industry is gradually reducing its wages, and evidently one object of the formal announcement as to prices was to remove the appearance of the steel mills receiving higher prices for their product than they really were receiving.

The Steel Corporation now pays 37 cents an hour for common labor, as do a few of the independents. Others are paying 33 cents and 30 cents, down to 27 and 25 cents, in the case of certain Eastern mills. Contractors in the Central West pay 25 and 30 cents.

The mills are giving the workmen the better end of the bargain. The rate for common labor before the war—as a matter of fact from February 1, 1913, to February 1, 1916—was 19 cents. With steel prices 50 to 60 per cent higher, a corresponding rate would be 30 cents, and that probably will be the final objective, but not until steel prices have further declined.

At the end of 1914 steel prices had practically returned to their historic low level, made in 1897 and 1898, when the wage rate was 13 cents. The mills had absorbed a 50 per cent increase in wages, by making improvements in methods and appliances. They cannot absorb another 50 per cent wage increase, because they have not made corresponding improvements, nor have they anything from which to absorb the great increases in freight rates, but it is plainly the spirit of the industry to pay fair wages and have wages dictate the price of steel rather than allow steel prices to dictate wage rates.

British Chemical Industries

(FROM OUR LONDON CORRESPONDENT)

LONDON, June 17, 1921.

INDUSTRIAL troubles are still with us and prophets have either gone out of business or are utterly discredited. The end does not yet seem in sight either as regards coal or for many other industries in which the pendulum is swinging against the operatives. A state of affairs which, according to quite reasonable predictions on the pre-war basis, should mean the complete and utter ruin of this country has been borne by the general public with an uncanny apathy amounting almost to stoicism and by manufacturers with an uncrushable optimism of the "it might be even worse" variety. The undertone in chemical markets continues good, and in spite of the adverse conditions prices are well maintained.

GAS WORKS OPERATE UNDER DIFFICULTIES DURING THE COAL STOPPAGE

The public during the last two months has relied largely on the gas companies and the flexibility of modern plant is well illustrated by the manner in which all difficulties were overcome. French coal was chiefly used and a certain amount also arrived from Germany and Pittsburgh. On account of the somewhat heavy percentage of ash in the French coal and its smaller yield in residuals, costs in raw materials per "therm" were much greater than for British coal, while the heavy freightage militated against the extended use of American fuel. Sulphur in all cases was lower than for British coal, but in spite of all efforts the various gas companies are faced with heavy losses in operation which could only have been partly avoided by shutting down. Heavy petroleum distillates being now relatively cheap owing to the fall in oil prices, carburetted water gas was extensively used, and this as well as prompt supplies of French coal really saved the situation. The gas works engineers have had an anxious time technically and perhaps the chief lesson learned is that if and when the British coal-mining industry returns to sane conditions, it will hardly have lost any of its market among the gas works.

FUEL RESEARCH BOARD PUBLISHES GAS RETORT STEAMING TESTS

The Glover-West retort was selected as the most suitable for these tests because of the ease with which the temperature can be controlled, and a setting of four retorts was installed during 1919 at the Experimental Station at East Greenwich. Coal from Durham, Yorkshire and Lanarkshire was tested as being of widely different types, and while at first 5 per cent of steam was used as a starting point, it was later on realized that a steamless starting point was necessary. It was common knowledge that steaming would lead to an increased yield of "therms" in the form of soluble gas, but the probable effects of steaming on the other products obtained was not so clear. The tests have shown that steaming also leads to increases in the yields of tar and ammonia at some slight sacrifice in the quantity and perhaps quality of the coke. It is concluded that provisionally 20 per cent of steam represents the economic limit for the time being subject to definite determination for different coals; the total gains obtained at an expense of 10 therms in the form of steam and fuel are stated to

be 33 therms of gas, 34 lb. of tar and 6 lb. of sulphate of ammonia, all reckoned per ton of coal.

TRADERS HANDICAPPED IN GERMAN TRADE

The debate on the safeguarding of industries bill ultimately degenerated into a free trade versus tariff reform controversy and no suggestions of a practical kind were made as an alternative to the bill. As in the case of other bills of this type, the House of Lords is far more likely to bring forward constructive criticism and sound arguments for and against its various provisions. While Parliament is dabbling with a half-hearted scheme, real attention has been focused upon Mr. McKenna's views embodied in an address on international debts. It is argued that in order to enable Germany to meet her final liability of close on 1,600 millions a year her exports must amount to not less than 4,800 million dollars. Obviously German foreign trade could not be expanded to this extent unless wages are kept extremely low with a corresponding rigid cutting down of the standard of living. Attention is drawn to the fact that Great Britain's international trade would be gravely impaired if Germany is able to meet her obligations, and this could only be partly avoided by reparations exports of coal, timber, potash, sugar and the like, this being equivalent to a handicap on German industry. Otherwise the reparations are shown to be really a bonus in favor of Germany, and shipping is given as an example.

Meanwhile importation of goods from Germany can be carried on only under great difficulties and with considerable delay, owing to the absence of official German announcements in regard to the refund of the 26 per cent reparations and export duty. The chief free imports at the moment are patents and processes of all kinds, which have been developed in ex-enemy countries during the war and which are being freely absorbed by British firms in the traditional manner.

NEW PROCESSES AND GENERAL NOTES

Considerable attention has been attracted to Mr. Hayhurst's new method of electrical heating and drying, in which the liquid is at no time at a higher temperature than the highest to which the liquid is to be raised. Further details will shortly be available, but it may be stated that the current in the one case is passed direct through the liquid and in the case of driers induced currents and hysteresis effects are utilized. During the war, electrical heating was developed in countries such as Italy, where coal was obtainable only at prohibitive prices, but in those cases electrodes were usually used. The present process from all accounts is likely to have extended application and of course particularly in localities where electrical energy is obtainable at low rates. Another interesting process is Calvert's for the synthetic direct production of alcohol from water gas and producer gas by catalysis. It is stated that ethyl alcohol of 99.2 per cent purity had been obtained from ordinary water gas with a yield of 90 per cent.

The announcement of the election of Dr. Ruttan to the presidency of the Society of Chemical Industry was unaccountably delayed at this end, although it was common property through American and Canadian sources. One of the new vice-presidents, C. S. Garland, is managing director of Lighting Industries, Ltd., and is one of the delegates to the forthcoming annual meeting in Canada.

Studies in Colorado Shale Oils

Results of Investigations on Shale Oils and Their Fractions, With Special Reference to Their Content of Sulphur and Nitrogen and to the Increased Saturation by Cracking

BY ARTHUR J. FRANKS

Oil analysis
Sulphur

IN A previous preliminary paper¹ the author presented some fundamental data on a number of Colorado shale oils which indicated clearly the similarity between the different products from the same type of oil shale. It was also shown that the heavy fractions of these shale oils are rather easily cracked on distillation at atmospheric pressure, the resulting distillates having a much higher saturation than the original oil. The only plausible explanation suggested for this phenomenon was that the increase in saturation might be due to the formation of new saturated compounds from some of the heavy unsaturated material. The present communication represents the results of further investigation on some of the same oils and their fractions, and deals mainly with the distribution of sulphur and nitrogen.

The unstable, unsaturated substances in Colorado shale oils are very complex and it would be a hopeless task to attempt to isolate and identify even a few of them without first studying some of the prominent general properties of the fractions in which they occur. The work done thus far in this direction only raises further questions instead of answering previous ones. Therefore it was thought advisable to proceed further with the preliminary investigation of the same oils before undertaking any general study of different types of oils or of the specific compounds in any one. It was hoped that simple distillations and analyses of the fractions for sulphur and nitrogen, in connection with the results obtained for saturation, specific gravity and temperature, would reveal, or at least indicate, some of these fundamental properties, as well as shed a little light on the phenomenon of increased saturation by cracking. Obviously, then, the purpose which underlies these preliminary studies is to discover the hidden road that leads to the main highway of ultimate investigation.

PRESENCE OF SULPHUR COMPOUNDS IN SHALE OILS

The distribution of sulphur, aside from its importance in connection with refining problems, may yield valuable information on the possible composition and properties of some of the compounds present in Colorado shale oils. In the dry distillation of the heavy fractions of these oils a strong odor of hydrogen sulphide is always noted, indicating decomposition of sulphur compounds. Since all of the heavy compounds of sulphur decompose more or less on distillation, this would be expected, and does not give any indication of the possible forms in which the element might occur. Casual examination and tests fail to give much additional information, except to indicate that the usual compounds do not seem to be present in quantity. The

Oil shales

only sulphur compounds that have ever been found in oils and the characteristics of which are known fall into the following classes: (a) Hydrogen sulphide; (b) carbon bisulphide;² (c) alkyl sulphides,³ or thioethers; (d) thiophenes;⁴ (e) thiophanes,⁵ and (f) mercaptans.⁶ Most of the sulphur in the oils studied does not seem to be present in any of these forms, but rather in forms suggesting an asphaltic nature and a very complex structure. Whatever their real nature may be, a knowledge of the amount of sulphur present will be of value, especially as a basis for other researches.

The accurate determination of small amounts of sulphur in oils presents many difficulties, especially when a great number of analyses are to be made. While sufficiently precise for most practical purposes, the usual technical methods give results which are not at all exact, even though considerable care is used in their application. Some of them contain such a number of sources of possible error that correct values obtain only by chance. Others are either long and awkward or require the use of such expensive apparatus that a large number of determinations becomes prohibitive. Since it is beyond the scope of this paper to discuss the relative merits and defects of different methods for determining sulphur, only the two which were actually tried will be given consideration.

It was realized early in the investigation that the only methods which could be utilized in making many accurate analyses on shale oils were the modified nitric acid method of Waters⁷ and the sodium peroxide fusion method devised by Edinger⁸ and modified by Parr.⁹ Waters' method was tried first, and the sulphur in the crude oils¹⁰ was obtained thereby. A brief outline of the procedure is not out of place.

NITRIC ACID METHOD FOR THE DETERMINATION OF SULPHUR IN SHALE OILS

Two grams of oil was weighed into a 75-c.c. casserole and 7 c.c. of concentrated nitric acid (previously saturated with bromine) was immediately added and the casserole covered with a watch glass. After all violent action had ceased the mixture was heated on a steam bath for about three hours, the crucible being gently shaken from time to time to insure complete

¹Chem. Zeit., vol. 21, p. 203.

²Mabery and Smith, *Ber.*, vol. 22, p. 3303 (1889).

³Meyer and Nahnsen, *ibid.* vol. 18, p. 217 (1885); Charitschoff, *Chem. Zeit.*, vol. 30, p. 476 (1906), and Girard, *Petroleum*, vol. 2, No. 3 (1906).

⁴Mabery and Quayle, *Proc. Amer. Acad.*, vol. 41, p. 89 (1905); Mabery, *J. Soc. Chem. Ind.*, vol. 19, p. 508 (1900).

⁵Höfer, *Erdöl u. s. Verw.*, 2d ed. p. 82.

⁶*J. Ind. Eng. Chem.*, vol. 12, pp. 482 and 612 (1920); U. S. Bureau of Stand. Tech. Paper 177.

⁷*Z. anal. Chem.*, vol. 34, p. 362 (1895).

⁸*J. Am. Chem. Soc.*, vol. 30, p. 767 (1908).

⁹CHEM. & MET. ENG., vol. 24, No. 3, March 30, 1921, p. 561.

¹⁰"Studies in Colorado Shale Oils," CHEM. & MET. ENG., vol. 24, No. 13, March 30, 1921, pp. 561-564.

attack by the acid. The casserole was then cooled and about 8 to 10 g. of dry, pure sodium carbonate was cautiously added and the mass stirred into a paste, a little water being added if necessary. The mixture was then dried thoroughly on a steam bath and carefully ignited to a white melt, which was later dissolved in water and the sulphur precipitated by barium chloride in the usual manner. Two blanks were run on each new lot of reagents, which are never pure.

The greatest difficulty encountered was that of too rapid combustion of the organic material when the mixture was fused, even with application of extreme care by the operator. The enormous heat developed often caused the volatilization of some of the salts, and in some cases considerable loss occurred by sputtering. However, careful duplicate determinations often checked fairly well, so that the reliability of the method was not questioned, in spite of the fact that results were occasionally obtained which varied widely. This was thought to be due to carelessness. Hence the publication of the best data for the sulphur in some of the crude oils was thought to be justified.

Recently, however, a large number of determinations has shown surprising vacillations in the amount of sulphur present in the different fractions. Since previous analyses gave no cause for anticipating such results the reliability of the method was finally suspected. Many redeterminations on the same oils proved that our suspicions were correct and that the results given are in error. The author does not attempt to advance any excuse for this unfortunate blunder, but takes the blame upon himself entirely. It is hoped that the present efforts will partly atone for this past mistake, as they bring to light the main failures in the method already mentioned, as well as those in the sodium peroxide fusion method which was eventually adopted. Since a complete discourse on this subject would be too long to be included here, only the main points will be considered briefly, a fuller and more detailed discussion being reserved for a later paper.

A careful study of the nitric acid method showed that the main defects were due to the use of too large a sample of oil (2 g.) and the use of an insufficient amount of sodium carbonate. When the sample of oil was reduced to 1 g., the volume of nitric acid (and bromine) to 5 c.c., and the weight of sodium carbonate increased to 12 g., concordant results were obtained, although they were still a trifle lower than those obtained by the fusion method. It has the additional disadvantage of being longer. In case Parr bombs are not available, however, the Waters method is to be recommended.

SODIUM PEROXIDE FUSION METHOD FOR THE DETERMINATION OF SULPHUR IN SHALE OILS

The peroxide fusion method does not give exact results unless a number of precautions are closely observed. Investigation has shown that with a good balance and extreme care it is possible to check determinations to within 1 per cent of the total sulphur present when this amounts to between 0.5 and 1.0 per cent of the oil. When more sulphur is present, the differences are, of course, proportionately smaller. Thus duplicate determinations on an oil containing 0.75 per cent of sulphur should agree as closely as 0.747 and 0.755. Frequently results have been obtained which check as closely as 0.748 and 0.752 per cent. These represent very accurate determinations when it is con-

sidered that those obtained by the usual methods seldom agree as closely as 0.74 and 0.76, which gives a difference of about 3 per cent of the total sulphur present. A brief description of the procedure eventually adopted is given in the following paragraph:

One measure of sodium peroxide, 1 g. of powdered potassium chlorate and 0.2 g. of benzoic acid are placed in a Parr bomb and well mixed by shaking. About 0.5 g. of the uniform sample is weighed into this mixture by means of a medicine dropper and a small weighing bottle. The whole mass is then thoroughly mixed over a piece of glazed paper with a thin glass rod, any solids adhering to the rod or falling upon the paper being subsequently returned to the bomb. After ignition in the usual manner the fusion is carefully dissolved in about 50 c.c. of water, the bomb thoroughly washed with water, the inside being finally rinsed with about 1 c.c. of concentrated HCl and a little more water, and the solution made acid with concentrated HCl. About 5 c.c. of saturated bromine water is then added to oxidize all the sulphur to sulphuric acid and the iron to the ferric condition. Ammonia is added until the liquid is alkaline and the solution brought to a vigorous boil to coagulate the ferric hydroxide and expel the excess ammonia. The former is then filtered off, a small wad of absorbent cotton being placed in the bottom of the filter to hasten the operation and facilitate washing. Four thorough washings with hot water are sufficient. The solution is acidified with 1 c.c. of concentrated HCl, made up to 225 c.c., brought

TABLE I. PERCENTAGE OF SULPHUR IN CRUDE OILS AND THEIR 10 PER CENT FRACTIONS

Oil No.	3	3a	5	7	9	2
Fraction No.						
Crude Oil	0.64	0.61	0.77	0.61	0.75	0.75
1	.48	.46	.64	.30	.67	..
2	.65	.59	.70	.49	.77	.77
3	.63	.59	.69	.59	.77	.78
4	.61	.58	.68	.68	.76	..
5	.60	.58	.66	.69	.74	..
6	.57	.54	.66	.68	.71	..
7	.49	.50	.64	.62	.64	.65
8	.38	.41	.54	.57	.45	..
9	..	..	.39	.52	.30	..
10	..	..	..	..	..	..

* Not enough of sample left for analysis.

to a boil and 5 c.c. of 10 per cent barium chloride solution is added slowly from a pipette. The boiling is continued until the precipitate is well formed, which sometimes requires as much as twenty minutes. About 200 c.c. of liquid will remain. After standing overnight the precipitate is filtered through a close 7-cm. filter paper (Munktell's No. 00 is preferred) and is carefully washed until free from chlorides. Ignition is made in a very small (about No. 000) porcelain crucible. The final precipitate will be pure and white. The sulphur is calculated from the barium sulphate weighed. A blank is run for each new lot of reagents and the gross result corrected accordingly.

The corrected results for the sulphur in the crude oils, together with those for the sulphur in the 10 per cent fractions, are given in Table I. The distribution of the sulphur is represented graphically by the curves in Fig. 1. The sulphur was not determined in the fractions of all the oils, because the results obtained are so similar that further analyses would be of no particular value. The corrected value for the sulphur in oil No. 1 is not given in the table, but is 0.72 per cent. A number of duplicate determinations are given for those fractions of oil No. 9 which furnish the turning points in the sulphur curve. The agreement is very

good. These results alone are indubitably not a sufficient basis for any conclusive generalizations; nor were they so intended. Yet they serve to establish a few facts and bring forth a number of important questions.

A study of the curves reveals a striking regularity in the apportionment of the sulphur among the various fractions. Obviously the 20 to 30 per cent cut contains the greatest percentage in every case except that of oil No. 7, which is not a representative crude oil, but a fractional condensate consisting of a mixture of light and heavy oils. It seems rather surprising to find such relatively small differences in the amounts of sulphur present in the different fractions. The very light oils

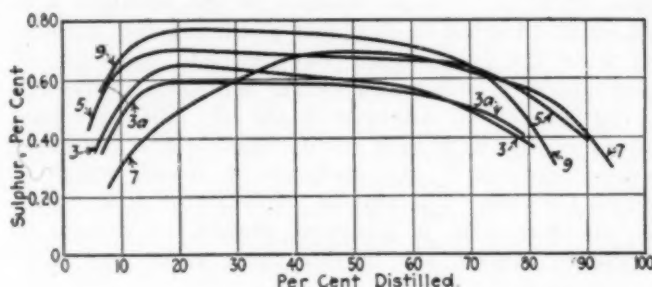


FIG. 1. SULPHUR CONTENTS OF SHALE OILS AND THEIR FRACTIONS

apparently contain the least sulphur, while there is but little variation between the percentages found in the middle cuts. It is very important to observe the decrease in the sulphur in the heavy oils, which is undoubtedly caused by cracking. This is evident if the sulphur curves are studied in connection with those for saturation, specific gravity and temperature.¹¹ Wherever the temperature ceases to rise, then falls, the specific gravity of the distillate at the same time decreasing and its saturation increasing (these phenomena being the criteria for cracking), a lowering is to be observed in the percentage of sulphur; and this becomes more and more pronounced as the cracking progresses. The lowering is not so great as might be expected, however, and there does not seem to be any quantitative relationship between this and other changes in the oils.

ACTUAL LOSS OF SULPHUR IN THE FRACTIONATION OF CRUDE SHALE OILS

The strong odor of hydrogen sulphide noted during the cracking of the heavy oils was an early indication of a loss of sulphur through a decomposition of at least a part of the complex sulphur compounds. That there is a considerable loss is unquestionable, as calculations from the analyses show. In order to compute the actual loss correctly, the total sulphur in the distillate must be subtracted from that in the crude oil. The difference between the average of the sulphur in the fractions and the sulphur in the crude is not the true loss at all. Since the falseness of the latter process of computation is not always obvious, the correct method is here given. The total sulphur in the distillate is the sum of 100 times the products of volume, specific gravity and percentage of sulphur in each fraction. The total sulphur in the crude oil is 100 times the product of volume, specific gravity and percentage of sulphur. The difference is, of course, the actual loss in weight

of sulphur. If the sulphur in the distillate of oil No. 9 is calculated in this manner, it is found to be 2.47 g., while that in the crude oil amounts to 3.50 g. Hence the loss of sulphur is 1.03 g., or 29.3 per cent of the total amount present.

The total loss in weight of oil by the distillation is 21.3 per cent, of which 11.0 per cent is coke. Now, if all the material that decomposed contained sulphur, it would mean that 8 per cent of all the sulphur (or 37.5 per cent of the decomposed material) failed to recombine to oil, but either escaped as hydrogen sulphide or remained in the coke. Such losses as these would account for the slight difference between the sulphur in crude oil No. 3 and that in the distillate No. 3a, the high percentage of sulphur in the light oils, and suggests that it will be impossible to eliminate much of the sulphur by cracking distillations. The fact that the cracking was always accompanied by a loss of sulphur by no means proves that the sulphur compounds only suffered decomposition, in spite of the fact that the phenomena always seem to occur together and at about the same temperature in every case. The evidence merely points in that direction. There is no doubt, however, that practically all the material which cracked was unsaturated (regardless of whether or not it was composed entirely of sulphur compounds) and that most of the saturated compounds were formed from the decomposition of this material.

COMPOSITION OF SULPHUR COMPOUNDS IN SHALE OILS

The sulphur curves of shale oils are significant in connection with the composition of the sulphur compounds present. The fact that the percentage of sulphur in the middle oils tends to be constant indicates a series of isomers. The pronounced deflection of the first part of all the curves signifies the presence in the light oils of a different series of sulphur compounds from those found in the heavier fractions. The cracking of the heavy oils obscures the true distribution of the sulphur therein, but the writer is of the opinion that there would have been a regular decrease in the sulphur in these oils had the cracking been prevented, in which case the curves would have approached straight lines. This would indicate a third series of sulphur compounds—a homologous series—in which each individual member contained the same number of sulphur atoms. Still other series might, of course, occur in such proportions as to give the same apportionment of the sulphur as here observed. This is quite probable. Much more work will have to be done, however, before any of these suggestions can be established as facts. They are mentioned at present only for the purpose of pointing out the course of future investigations, and to stimulate further research.

PRESENCE OF NITROGEN COMPOUNDS IN SHALE OILS

It is a well-known fact that the products from the carbonization of most bituminous materials contain nitrogenous compounds, and researches on different shale oils have shown that they also contain such substances. Investigators have already isolated and identified a number of heterocyclic nitrogen compounds from Scotch shale oils and some have been detected in Green River oils. The most exhaustive research has, however, been done on petroleum.

The possible forms in which the nitrogen might occur in Colorado shale oils are numerous, but the most im-

¹¹CHEM. & MET. ENG., vol. 24, No. 13, March 30, 1921, p. 561.

portant may be classed under the following heads: (a) Pyridines; (b) pyrrols; (c) quinolines; (d) amines, and (e) very complex substances similar in their nature to asphalt. Preliminary tests seem to indicate the presence of all of these forms.

Williams¹² has long ago isolated and identified pyrrol, pyridine, methyl and dimethyl pyridines, and parvoline in a crude naphtha from a Dorsetshire shale oil. Morrell and Egloff¹³ have reported qualitative evidence of pyridine and its homologues in Green River oils. Beilby¹⁴ has done considerable work on the nitrogen in oils from Scotch shales, but he made no attempt to isolate or identify the individual compounds. In spite of the great importance of such knowledge, relatively little has been published and the literature is very meager.

Before making any attempt to determine the classes of compounds present in the oils studied or to identify the individual members of any series it was thought advisable to investigate first the distribution of the nitrogen among the different fractions, since this would yield preliminary information of importance. Three typical oils were chosen for this work—Nos. 5, 6 and 9. The results obtained were so characteristic that further analyses were deemed unnecessary. The nitrogen was determined in all cases by a slight modification of the Kjeldahl-Gunning method. A brief description will indicate its simplicity.

One gram of oil was weighed from a small bottle into a 500-c.c. Kjeldahl flask and immediately treated with 20 c.c. of concentrated sulphuric acid. Ten grams of

sodium hydroxide run into the flask through the funnel until the solution turned to a deep blue, and an excess of about 10 c.c. of the alkali added. The ammonia was cautiously distilled into 50 c.c. of N/20 sulphuric acid into which the condenser tube dipped from the time the alkali was first introduced until water began to condense. The level of the acid was then lowered until it barely touched the tube of the condenser. When about 75 to 100 c.c. of water had distilled over, the distillation was discontinued, the condenser tube rinsed with water, and the excess acid titrated with N/20 sodium hydroxide solution, using a few drops of cochineal for an indicator. The endpoint was always compared with that obtained by a fresh titration of equal volumes of the standard acid and alkali in order to eliminate possible error in judging when the proper color was reached. Each c.c. of sulphuric acid neutralized by the ammonia represents 0.0700 per cent of nitrogen in the oil. Blanks should always be run with each lot of reagents and the gross result corrected if any ammonia is found, which is seldom the case. The pipette (or burette) from which the standard acid is measured should, of course, be calibrated against the burette from which the alkali is measured.

The copper sulphate was used to accelerate the decomposition of the oil and to serve as an indicator in the addition of the strong alkali. Phenolphthalein could not be used for the latter purpose because it seemed to induce troublesome foaming during the distillation.

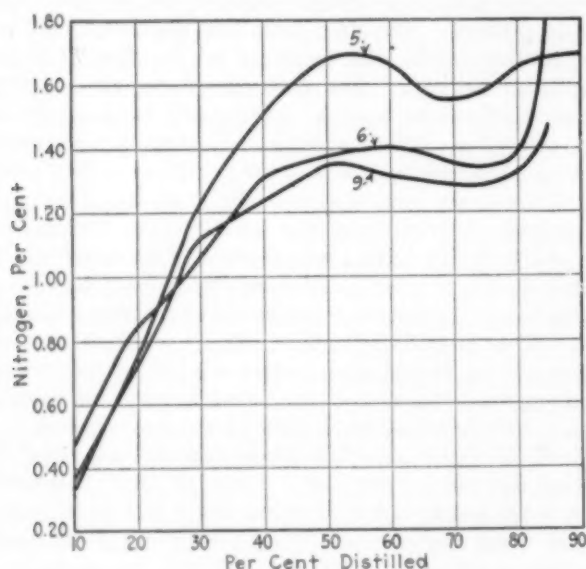


FIG. 2. NITROGEN CONTENTS OF SHALE OILS AND THEIR FRACTIONS

potassium acid sulphate and a small crystal (about 0.2 g.) of copper sulphate were then added and the mixture digested until a clear solution was obtained. This required about two and one-half hours. When completely cooled the contents of the flask were diluted with cold water to about 200 c.c., again cooled, a few glass beads introduced, and a small dropping funnel and a Kjeldahl connector were placed in the flask through holes in a tightly fitting rubber stopper. Connection was made with a water-cooled condenser, a strong solu-

TABLE II. PERCENTAGE OF NITROGEN IN CRUDE OILS AND THEIR 10 PER CENT FRACTIONS

Oil No.	5	6	9
Fraction No.			
Crude Oil.	1.855	1.608	1.501
1.	0.344	0.466	0.361
2.	0.742	0.837	0.721
3.	1.239	1.140	1.120
4.	1.491	1.307	1.232
5.	1.674	1.365	1.344
6.	1.659	1.404	1.305
7.	1.540	1.351	1.285
8.	1.654	1.374	1.316
9.	1.685	1.883	1.470

The use of copper sulphate permits the saving of about one hour in the decomposition of the oil, about three and one-half hours being required when it is absent. The alkali was introduced in the manner described, because slight losses of ammonia were sometimes obtained during neutralization of the solution in the usual way. The loss of ammonia could, of course, be prevented by greater dilution of the acid and the use of less concentrated alkali; but this would mean that the liquid would have to be transferred to a larger flask before distillation and that a greater amount of water would have to be distilled over to insure complete expulsion of the ammonia. This causes an unnecessary waste of time, especially when a great number of determinations are to be made.

No difficulties were encountered with this method and duplicate determinations checked very closely. Agreement to within one or two thousandths of one per cent are quite common and the difference never exceeds one hundredth of one per cent when analyses are carefully made. The results obtained for the crude oils and their 10 per cent fractions are given in Table II. The distribution of the nitrogen is represented graphically by the curves in Fig. 2.

The amount of nitrogen in these oils is comparatively large and exceeds that found in most petroleum, with

¹²J. Chem. Soc., vol. 7, p. 97 (1854).

¹³CHEM. & MET. ENG., vol. 19, No. 2, July 15, 1918, p. 95.

¹⁴J. Soc. Chem. Ind., vol. 3, p. 216 (1884).

the exception of some from California, Japan and Algeria.¹⁵ Analyses of the fractions show that most of the nitrogen lies in the oils boiling above 225 deg. C., and that the amount tends to increase as the boiling point rises. A comparison of the nitrogen curves reveals a number of irregularities, but they all have the same general shape, which would be expected from the fact that the oils are very similar in other respects.

LOSS OF NITROGEN IN THE FRACTIONATION OF CRUDE SHALE OILS

As the curves (Fig. 2) indicate, the distribution of nitrogen in the oils is very much disturbed by the cracking, which causes a great loss in the total amount of nitrogen recovered in the distillates, the losses being proportional to the extent of the decomposition, as the results and calculations therefrom show. If this loss is computed in the same manner as that for sulphur, it will be found to be 41.2 per cent in the case of oil No. 9, 43.9 per cent for oil No. 6, and 35.9 per cent for oil No. 5. Hence the total percentage loss of nitrogen greatly exceeds that for sulphur under the same conditions. This might be explained in one of two ways: Either this nitrogen and sulphur are present in a series of compounds that decompose during the cracking in such a manner that most of the sulphur later recombines while the greater part of the nitrogen fails to do so, or they are present in separate classes of compounds, those containing the nitrogen being the more unstable. The first hypothesis seems by far the more plausible when the relative chemical reactivities of sulphur and nitrogen are considered and because it is a general rule that a loss in one is always accompanied by a loss in the other. The high percentage of nitrogen in the heavy fractions is evidence of the presence of one or more other classes of nitrogenous compounds which are quite stable. The data are, of course, too meager to permit the deduction of any more definite conclusions as to the possible character of the different kinds of compounds.

CONFIRMATION OF THE HYPOTHESIS THAT UNSATURATED COMPOUNDS ARE CHANGED BY CRACKING INTO SATURATED COMPOUNDS

The simultaneous loss of nitrogen and sulphur and gain in saturation forms interesting evidence in support of the hypothesis that unsaturated, unstable material is the source of the saturated compounds produced by cracking of the heavy fractions of Colorado and similar shale oils. That this unsaturated material is made up of a series of unstable compounds of high molecular weight and rich in nitrogen and sulphur (and perhaps oxygen), as the results suggest, seems very plausible. In spite of the strangeness of the phenomenon, it would not be difficult to conceive how, under suitable conditions, it would be possible for the molecules of such unstable substances to disintegrate completely and for the atoms or groups to recombine immediately to more stable series of compounds, such as paraffines, aromatics, alicyclics, olefines and their sulphur and nitrogen derivatives. It would certainly be unlikely, if not impossible, for the resulting products to be as unstable as the original material or less so. The results obtained are, therefore, not contrary to theory, but might almost be expected. An enormous amount of work will have to be done, however, before the suggested hypothesis can be conclusively proved.

¹⁵Engler-Höfer, "Das Erdöl," vol. I, 1913.

SUMMARY

The usual technical methods for determining sulphur in oils are found to be inexact. A slight modification of Parr's method gave accurate results and was used to determine the distribution of sulphur in five of the oils previously studied. The apportionment of the sulphur is quite uniform for all the oils that were investigated, and is such that there are comparatively only slight differences between the amounts present in the various 10 per cent fractions, the percentage being greater in the 20 to 30 per cent cut and tending to remain constant in the middle oils. The sulphur is less in the light and heavy oils, the amount being reduced in the latter by cracking, showing that at least part of the compounds which decompose contain sulphur. The total loss of sulphur during the distillation was about one-third of the amount present in the crude oil. In spite of this, the distillate contains about the same percentage as the original oil. The distribution of the sulphur as represented by the curves suggests the presence of at least three different series of sulphur compounds, two of which seem to be quite stable. The simultaneous loss of sulphur and gain in saturation by cracking indicate that the unsaturated material which is the source of the new saturated compounds contains sulphur.

Colorado shale oils and their fractions contain much nitrogen, which seems to be present as basic compounds, and complex, unstable, unsaturated substances of high specific gravity and molecular weight. The distribution of nitrogen is similar for each of the three oils studied, the heavier fractions containing by far the larger amounts. Cracking of the latter during distillation effects a great loss of nitrogen and masks its true distribution. The total loss observed was about 40 per cent of the nitrogen occurring in the crude oil, showing that one of the classes of nitrogenous substances is very unstable.

The simultaneous loss of nitrogen and sulphur and increase in saturation by cracking suggests the hypothesis that the saturated oils thus formed are produced from unsaturated compounds containing sulphur and nitrogen, which are easily decomposed under the conditions that obtain during a destructive distillation, yielding oils of a more stable and saturated nature. Work is now being done on the changes wrought by successive distillations of shale oils. The results should yield valuable evidence in support of this hypothesis.

ACKNOWLEDGMENT

The author takes this opportunity to express his indebtedness to C. P. Hackett, who helped to work out the method for determining nitrogen and who made the analyses, and to J. P. Bacca, who aided in developing the method for determining sulphur and made the determinations. The writer is also indebted to Prof. A. H. Low for his valuable criticisms and suggestions in the preparation of this paper.

Department of Chemistry,
Colorado School of Mines,
Golden, Col.

Production of Alcohol in Poland

This year's production of alcohol in Poland, according to the *Kurjer Polski*, a newspaper of Warsaw, will be about 40,000,000 liters, of which 30,000,000 liters will be exportable. Last year's alcohol production was only 10,000,000 liters (1 liter = 0.264 gal.).

Constitution of Gas Atmospheres in Aluminum-Alloy Melting Furnaces

Tabulated Analyses of Atmospheres of Various Types of Aluminum Furnaces, Sampled at Short Intervals During Operation, Furnishing Data Necessary for a Study of Dross and Metal Losses Due to Furnace Operation

BY ROBERT J. ANDERSON AND J. H. CAPPS

AS INDICATED in a previous contribution,¹ "Gases in Aluminum Furnaces and Their Analysis," the Bureau of Mines set out to determine by actual analysis the constitution of the gas atmospheres in industrial melting furnaces used for light aluminum alloys, under foundry operating conditions. A portable gas-sampling apparatus was devised, and a large number of samples taken and analyzed, the results of which are given below.

STATIONARY, OPEN, IRON-POT FURNACE

Gas samples were taken from the atmosphere above the metal in a stationary, oil-fired, iron-pot furnace, run without a cover, such as sketched in Fig. 1. The oil was injected by air under pressure, and steam was not employed for oil atomization in any of the furnaces which were sampled. The furnace was one of several units run as a battery in a bank, the waste gases from the combustion discharging into the air at one end of the bank. In furnaces of this type the iron pot is heated over its exterior surface, and there is practically

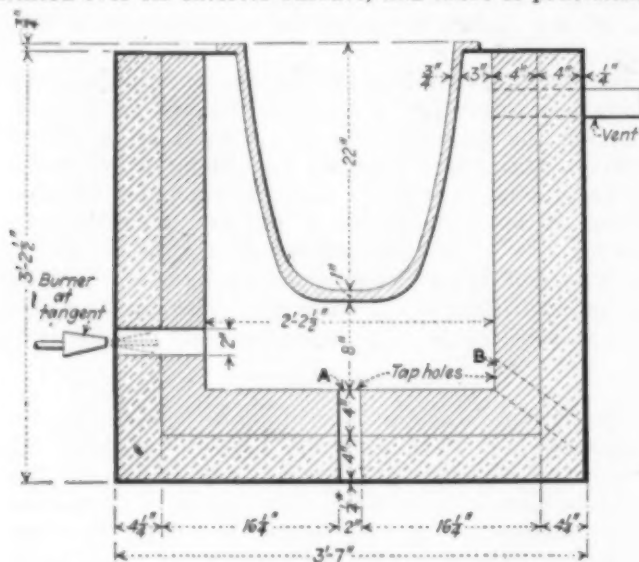


FIG. 1. CROSS-SECTION OF STATIONARY, OPEN, IRON-POT FURNACE

no opportunity for the products of combustion to come into contact with the metal during melting. The sampling tube was supported on a suitable stand, and the intake end was hung within 1 in. of the bath surface at about the center. The melting charge consisted of aluminum pig plus 50:50 copper-aluminum alloy, No. 12 alloy pig, and No. 12 alloy foundry scrap. There was

doubtless no contaminating material in the charge which could have given rise to gases on heating.

As might be expected, the gas in contact with the surface of the liquid metal in an open iron-pot furnace would consist of practically unaltered air. Normally, however, owing to draughts or leakage from the combustion space, the gas contains either a small percentage of unburned hydrocarbons (from 0.0 to 0.4 per cent) or their combustion products (H_2 from 0.0 to 0.2; CO , from 0.0 to 0.2) or both, in addition to oxygen and nitrogen. Methane was tested for and not found. Since the gas in contact with the liquid metal in a furnace of this type is practically unaltered air, it is evident that dross formation is a direct function of the temperature. The higher the melting temperature the greater the loss by oxidation and nitridation.

STATIONARY, CLOSED, IRON-POT FURNACE

A number of gas samples were taken from the atmosphere above the metal in a stationary, gas-fired, iron-pot furnace, run with a dome-shaped cast-iron cover (Fig. 2). Natural gas was the fuel. The furnace was operated as a single unit, the waste products from the combustion discharging up a small stack connected to the side of the furnace wall. As in furnaces of the foregoing type, the iron pot is heated over its exterior surface, and there should be but little opportunity for the products of combustion to come into contact with the metal during melting. The furnace charge consists of No. 12 alloy scrap (castings, gates, and risers), 50:50 copper-aluminum alloy, and baled aluminum clippings made up so as to give a final alloy of approximately No. 12 composition.

Contrary to what might have been expected, the furnace atmosphere contained quite large percentages of carbon dioxide, and the oxygen and nitrogen contents were rather variable. The burning of oil on the clippings might be expected to show momentarily the presence of considerable carbon dioxide, but this constituent should not be expected to persist during the course of a melting period. The oxygen content of the atmosphere was increased when the cover was opened for charging metal. The high percentage of carbon dioxide may be due to burning out of the carbon in the cast-iron pot or cover since the oxygen is decreased and the nitrogen increased as compared with the percentage of these constituents in air. There may, of course, be some leakage of the products of combustion into the space above the metal which would account for the carbon dioxide content of the atmosphere. Omitting the figures obtained for samples taken after the cover was open, the range of composition for carbon dioxide, nitrogen

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¹See CHEM. & MET. ENG., vol. 24, No. 23, June 8, 1921, p. 1019.

and oxygen was as follows: 7.2 to 9.8 per cent carbon dioxide, 84.7 to 86.6 per cent nitrogen, and 3.5 to 8.1 per cent oxygen. Fractional percentages of carbon monoxide, hydrogen and unsaturated hydrocarbons were found once. The atmosphere of this furnace may be considered to be oxidizing, and both oxidation and nitridation of the metal will take place on melting.

STATIONARY, CRUCIBLE FURNACE

Gas samples were taken from the atmosphere in the interior of the crucible in a stationary, gas-fired, crucible furnace run without a cover. Natural gas was the fuel. In this furnace, somewhat as shown in Fig. 3, the crucible was simply set in a round iron shell lined with firebrick, and the crucible was heated over its exterior surface by the combustion of the fuel. The waste gases were discharged through a large hole in the furnace cover. No cover was used on the crucible. In a furnace of this type there is ample opportunity for the products of combustion to come into contact with the metal during melting, since they are discharged with a rotating motion through the top of the furnace. The burner was set so that the flames were projected tangentially and with a rotating and upward motion around the crucible.

The sampling tube was admitted to the atmosphere in the crucible above the liquid metal through the large hole in the top of the furnace and the intake end was held at a point in the center of the crucible space about 1 in. from the surface of the alloy. Analyses of a number of samples from this furnace are given in Table I. The charge contained about 86.0 per cent aluminum,

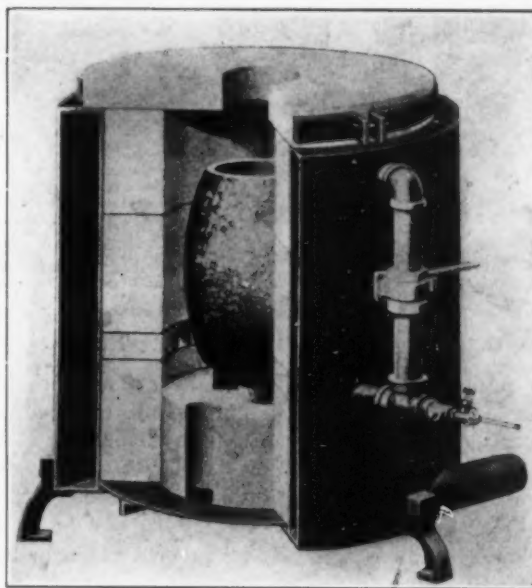


FIG. 3. SECTIONAL PERSPECTIVE OF STATIONARY CRUCIBLE FURNACE

7.0 per cent copper and 7.0 per cent tin (made up by adding tin to No. 12 alloy pig).

As might be expected, the gas in contact with the surface of the liquid metal in a furnace of this type depends intimately upon the fuel used and the operating details (air supply, etc.). The products of combustion are passing over the metal surface at a fairly rapid rate during melting. As will be noted from Table I, the gas

in contact with the liquid metal contained large amounts of nitrogen. It cannot be considered as oxidizing on the basis of the oxygen content of the gases. The variations in carbon dioxide, carbon monoxide, hydrogen and methane are traceable to variations in the air supply and in the speed of the combustion. It is entirely likely that variations in the constitution of the furnace atmosphere as large as those indicated in the table would be obtained by sampling different parts of the combustion space. Hence the analyses as given are useful only in so far as they indicate the variations in the composition of the atmosphere.



FIG. 2. BATTERY OF COVERED POT FURNACES. POTS REMOVED FROM FURNACES AT FAR END OF LINE

TABLE I. ANALYSES OF GASES IN CONTACT WITH METAL IN A STATIONARY, GAS-FIRED, CRUCIBLE FURNACE

Time Sample Drawn	Composition, Constituents Per Cent, by Volume						Oxygen, O ₂	Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Unsaturated Hydrocarbons, C ₂ H ₄ , etc.	Nitrogen, N ₂ (by difference)		
2:47	7.3	3.9	2.5	4.1	1.3	78.5	2.4	Metal charged.
2:53	7.4	4.1	3.3	3.3	0.4	79.7	1.8	Metal melting.
2:57	6.9	5.5	4.4	3.5	0.6	77.6	1.5	Metal melting.
3:01	6.7	5.1	3.5	2.9	0.0	79.4	2.4	Metal melting.
3:07	8.2	4.8	4.0	2.1	0.4	80.1	0.4	Metal melting.
3:12	7.7	5.5	4.7	2.2	0.4	79.3	0.2	Metal melting. No 12 pig charged.
3:16	7.7	4.1	3.1	1.1	0.2	81.7	2.1	Metal heating.
3:20	7.5	5.9	4.5	2.3	0.0	79.3	0.5	Metal heating.
3:25	7.6	5.7	4.5	1.8	0.0	79.8	0.6	Metal heating.
3:35	9.6	3.3	2.4	0.5	...	83.2	1.0	Metal heating.
3:39	7.4	6.3	6.2	1.6	0.4	77.8	0.3	Metal heating.
3:43	7.8	6.2	6.0	1.1	0.4	78.5	0.0	Metal heating.
3:48	7.6	5.5	5.3	1.0	0.6	79.3	0.7	Metal heating.
3:53	7.8	5.2	4.6	0.8	....	81.1	0.5	Metal heating, temperature 790° C.

TABLE II. ANALYSES OF GASES IN CONTACT WITH METAL IN A STATIONARY, OIL-FIRED, SEMI-PIT, CRUCIBLE FURNACE

Time Sample Drawn	Composition, Constituents Per Cent, by Volume			Remarks
	Carbon Dioxide, CO ₂	Nitrogen, N ₂ (by difference)	Oxygen, O ₂	
11:12	12.8	83.1	4.1	Metal heating.
11:30	13.3	83.3	3.4	Metal heating; ready to pour.
12:12	14.5	83.5	2.0	New charge; metal melting.
12:26	14.1	83.6	2.3	Metal melting; flame smoky.
12:36	13.0	82.8	4.2	Metal melting; flame not smoky.
12:40	14.2	83.2	2.6	Metal melting; flame not smoky.
12:44	13.6	83.1	3.3	Metal melting; flame not smoky.
12:55	14.0	83.0	2.8	Metal melting; flame not smoky.

STATIONARY, SEMI-PIT, CRUCIBLE FURNACE

Gas samples were taken from the atmosphere in the interior of the crucible in a stationary, oil-fired, semi-pit, crucible furnace, run without a cover. Fuel oil of unknown composition was used. In this furnace the crucible for melting the alloy was set in a cylindrical iron shell lined with firebrick. The lower half of the shell was set down in a pit. The crucible was heated over its exterior surface by the combustion of the fuel. The waste gases were discharged through a large hole in the furnace cover. No cover was used on the crucible. In a furnace of this type there is also ample opportunity for the products of combustion to come into contact with the metal. The intake end of the sampling tube was held at a point in the center of the crucible space about 1 in. from the surface of the alloy. Analyses of a number of samples from this furnace are given in Table II. No. 12 alloy was melted, and the charge was made up of No. 12 foundry scrap, aluminum pig and 50:50 copper-aluminum alloy.

In the installation under discussion the gas in contact with the liquid alloy during melting was of fairly uniform composition. As will be noticed from Table II, the gas consisted largely of nitrogen and carbon dioxide, with smaller amounts of oxygen. No carbon monoxide or methane was found, and only 0.1 per cent of hydrogen and unsaturated hydrocarbons was detected in one of the samples. Both oxidation and nitridation of the metal would occur in the atmosphere of this furnace.

TILTING, CRUCIBLE FURNACE

Gas samples were taken from the atmosphere in the interior of the crucible in a tilting, crucible furnace of a special design using a good grade of metallurgical coke. In this furnace the crucible for melting the alloy was supported in the furnace shell and heated by the combustion of coke on a grate beneath. The waste gases passed up and around the uncovered crucible and were discharged through a large hole in the furnace cover. Both natural and forced drafts were employed on the

furnace. In this furnace there was ample opportunity for the products of combustion to come into contact with the metal during melting. Analyses of a number of samples from the furnace are given in Table III. No. 12 alloy was melted, and the charge was made up of No. 12 foundry scrap, aluminum pig and 50:50 copper-aluminum alloy.

For natural draft the gas in contact with the liquid alloy during melting was of fairly uniform composition, but the variations were more marked in the case of forced draft. The effect of forced draft upon the constitution of the gas atmosphere is plainly shown. The carbon dioxide content of the gas is higher and the oxygen content much lower, indicating more perfect combustion of the gases before egress from the furnace. When the draft was reduced the carbon dioxide was lowered and the oxygen raised. The high carbon monoxide content of sample taken at 2:17 may be due to several causes—for example, too rapid egress of the unburned gases. Unsaturated hydrocarbons were tested for but not found in any of these samples.

Both oxidation and nitridation of aluminum would occur in a furnace atmosphere of the compositions indicated. It would have been interesting to study the variations in the atmosphere of this furnace over a wide range of draft pressures, but this was impossible.

REVERBERATORY FURNACE

Gas samples were taken from the atmosphere in the interior of an open-flame, oil-fired reverberatory-type furnace. In this furnace the melting was done upon the furnace bottom; fuel was supplied through three burners at one end, and combustion took place in the space between hearth and roof. The products of combustion were discharged into a large stack.

The furnace was approximately 10.0 ft. long by 6.0 ft. wide by 4.0 ft. high inside. There were two large charging doors and a single tapping runner on each side. Considerable air was sucked into the furnace through cracks and holes in the walls and around the doors and burners.

The sampling tube was admitted into the interior of the furnace under the different charging doors, held at various points usually about equidistant from the opposite charging doors and close to the surface of the bath. Analyses of a number of samples taken are given in Table IV. No. 12 alloy was melted, and heavy foundry scrap was used exclusively in the charges.

By reference to the table, it will be seen that the composition of the gas atmosphere in this furnace was very variable, especially as regards carbon dioxide and oxygen. Omitting the figures which are traceable to

TABLE III. ANALYSES OF GASES IN CONTACT WITH METAL IN A TILTING, COKE-FIRED, CRUCIBLE FURNACE; NATURAL AND FORCED DRAFT

Time Sample Drawn	Composition, Constituents Per Cent, by Volume						Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂	Oxygen, O ₂	
1:00	6.1	0.1	0.0	0.2	79.2	14.4	Metal heating; natural draft.
1:09	9.2	0.4	0.2	0.0	79.7	10.5	Metal heating; natural draft.
1:15	2.4	0.3	0.0	0.0	79.4	17.9	Metal heating; natural draft.
1:20	5.8	0.0	0.0	0.0	79.5	14.7	Metal heating; natural draft.
1:25	3.2	0.3	0.0	0.0	79.0	17.5	Metal heating; natural draft.
1:30	3.1	0.0	0.0	0.0	79.4	17.5	Metal heating; natural draft.
1:35	5.8	0.0	0.0	0.0	79.4	14.8	Metal heating; natural draft.
2:17	13.3	11.2	0.8	0.1	74.4	0.2	Another charge; metal heating; forced draft.
2:23	16.7	6.0	0.3	0.1	76.7	0.2	Metal heating; forced draft.
2:28	13.2	3.8	0.1	0.1	77.5	5.3	Metal heating; forced draft; scrap charged.
2:32	19.1	0.4	0.0	0.0	79.3	1.2	Metal heating; forced draft.
2:37	13.3	0.2	0.0	0.0	79.7	6.8	Metal heating; forced draft; scrap charged.
2:42	3.6	0.0	0.0	0.0	79.8	16.6	Metal heating; draft much reduced.
2:48	3.1	0.0	0.0	0.0	79.1	17.8	Metal heating; draft much reduced.
2:52	13.9	0.3	0.0	0.0	79.1	6.7	Metal heating; strong forced draft.
2:56	12.8	0.0	0.0	0.0	80.9	6.3	Metal heating; strong forced draft.

definite operating conditions, it is evident that the atmosphere is oxidizing. Taking the last twelve samples, which cover a melting period when the operating conditions were fairly uniform, the composition of the atmosphere ranged about 4.5 per cent CO_2 , 14.5 per cent O_2 , and 80.8 per cent N_2 . Both carbon monoxide and methane were found in small percentages in certain of the samples, but hydrogen was detected (0.1 per cent) in only one sample. Both oxidation and nitridation would occur in a furnace atmosphere of this type. Since the gases are passing over the metal at a rapid speed, the gross loss would be a function of the temperature, the composition of the atmosphere and the speed of passage of the gases.

Reverberatory practice is generally to run continuously—cold metal being added periodically to keep pace with the rate of pouring. Since the doors are opened

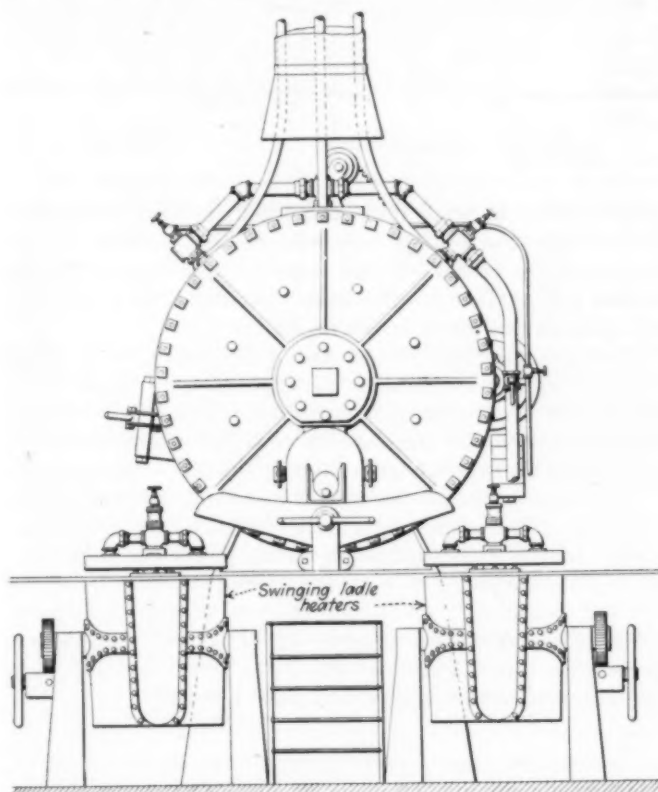


FIG. 4. END ELEVATION OF OPEN-FLAME STATIONARY FURNACE

from time to time, the atmosphere may be expected to change periodically for this reason if no other. But the atmosphere did not vary widely in different parts of the furnace, as shown by the last set of analyses.

OPEN-FLAME, STATIONARY, CYLINDRICAL FURNACE

Gas samples were taken from the atmosphere in the interior of the open-flame, oil-fired, stationary cylindrical furnace of the Schwartz type sketched in Fig. 4. In this furnace the melting was done upon a cylindrical bottom; the fuel was supplied through two burners on the side, and the combustion took place in the space between the surface of the metal and the cylindrical walls of the furnace. The products of combustion were discharged into the air through a hole in the top of the furnace. The furnace was about 10 ft. long by 5 ft. in diameter inside. There were two charging doors at the side and the end. In this furnace, as in other open-flame furnaces, there was ample opportunity for the products

TABLE IV. ANALYSES OF GASES IN CONTACT WITH METAL IN AN OPEN-FLAME, OIL-FIRED, REVERBERATORY-TYPE FURNACE

Time Sample Drawn	Composition, Constituents Per Cent, by Volume					Remark
	Carbon Diox- ide, CO ₂	Carbon Mon- oxide, CO	Methane, CH ₄	Nitrogen, N ₂ (by difference)	Oxygen, O ₂	
Tube supported in iron pipe; 3½ ft. in the furnace						
10:50 (F)*	4.15	0.0	0.02	82.65	13.18	Burners off; metal be- ing tapped
11:45 (F)†	5.48	0.0	0.04	81.34	13.14	Burners on; metal charged
11:50 (F)	8.86	0.0	0.03	83.43	7.68	Metal heating
12:45 (B)	6.17	0.0	0.33	87.62	5.88	Metal heating; metal charge
1:15 (B)	1.07	0.0	0.03	80.15	18.75	Metal heating; metal charged
1:25 (B)	0.8	0.0	0.1	88.4	10.7	Metal heating
Bare tube 10 in. in the furnace						
1:40 (F)	1.73	0.0	0.02	79.81	18.44	Metal heating
2:00 (F)	1.69	0.0	0.03	79.69	18.59	Metal heating
2:25 (F)‡	2.28	0.0	0.02	79.92	17.78	Metal heating
2:35 (B)	0.10	0.0	0.03	79.18	20.69	Burners off; metal being tapped
3:10 (F)	1.26	0.0	0.09	79.50	19.15	One burner on; metal being tapped.
3:20 (F)	0.14	0.0	0.03	79.03	20.80	One burner on; metal being tapped
Bare tube 3 ft. in the furnace§						
12:00 (B)	10.6	0.1	0.0	83.9	5.3	New charge; burners on
12:10 (B)	4.2	0.4	0.1	80.2	15.1	Metal heating
12:18 (B)	11.7	0.3	0.0	84.4	3.6	Metal heating
12:27 (B)	7.9	0.7	0.0	82.1	9.3	Metal heating
12:35 (B)	12.1	0.4	0.0	84.6	2.9	Metal ready to pour
Bare tube, 14 in. above the bath						
10:36 (F)	5.6	0.4	0.3	81.5	12.2	Another charge; burn- ers on
10:42 (F)	6.3	0.7	0.0	81.0	12.0	Metal heating
10:47 (F)	5.2	0.6	0.0	80.7	13.5	Metal heating
10:52 (F)	4.8	0.7	0.0	80.2	14.3	Metal heating
Bare tube 3½ ft. in the furnace; 4 in. above the bath						
10:58 (F)	4.8	0.6	0.1	81.0	13.5	Metal heating
11:03 (F)	4.8	0.6	0.0	80.6	14.0	Metal heating
11:12 ()	6.0	0.0	0.0	82.0	12.0	Metal heating
11:32 ()	6.6	0.0	0.0	80.9	12.5	Metal charged
11:45 ()	5.9	0.0	0.0	81.0	13.1	Metal heating
11:49 (V)	3.4	0.0	0.0	79.6	17.0	Metal heating
12:17 (B)	6.5	0.0	0.0	81.5	12.0	Metal heating
12:23 (B)	6.4	0.0	0.0	81.3	12.3	Metal heating

(F) Through door nearest the flue. (B) Through door nearest burners.

(M) Midway.

* Temperature of gas near the burners was 595 deg. C.; flue gases, 810 deg. C.; liquid metal, 905 deg. C.

† Temperature of gas near the burners was 1,165 deg. C.; flue gas, 1,090 deg. C.; and liquid alloy, 705 deg. C.

‡ Temperature of liquid alloy, 880 deg. C.

§ The heat softened the quartz sampling tube so that it sagged.

of combustion to come into intimate contact with the metal.

Owing to the fact that the incandescent gases were constantly in violent motion, it was not necessary to place the sampler very close to the bath. It was admitted through a hole in the end charging door and luted with clay. The end was held at a point about 3 ft. in the furnace from one end and midway between the opposite walls, several inches above the metal surface.

Analyses of a number of samples are given in Table V. No. 12 alloy was melted, the charge consisting of No. 12 alloy pig, aluminum pig plus 50:50 copper-aluminum alloy, and heavy foundry scrap.

The constitution of the gas atmosphere in a closed furnace of this type should remain fairly constant for a given set of operating conditions, and the constituents present in the gases, as shown by the table, vary within

TABLE V. ANALYSES OF GASES IN CONTACT WITH METAL IN A STATIONARY, OIL-FIRED, OPEN-FLAME, CYLINDRICAL FURNACE (SCHWARTZ TYPE)

Time Sample Drawn	Composition, Constituents Per Cent, by Volume					
	Carbon Dioxide, CO_2	Carbon Monoxide, CO	Hydrogen, H_2	Methane, CH_4	Nitrogen, N_2 (by difference)	Oxygen, O_2
3:00	13.7	1.7	0.8	0.3	82.8	0.7
3:04	12.8	2.9	1.7	0.2	82.2	0.2
3:09	13.9	0.4	0.3	0.0	84.1	1.3
3:13	14.1	1.2	0.2	0.5	83.8	0.2
3:17	14.1	1.0	0.5	0.1	84.1	0.2
3:25	13.4	2.2	0.9	0.1	83.3	0.1
3:36*	14.6	0.0	0.0	0.0	84.3	1.1
3:41	14.1	0.0	0.0	0.0	83.9	2.0
3:55	13.5	0.0	0.0	0.0	84.5	2.0

* Bath stirred and fluxed with ZnCl_2 .

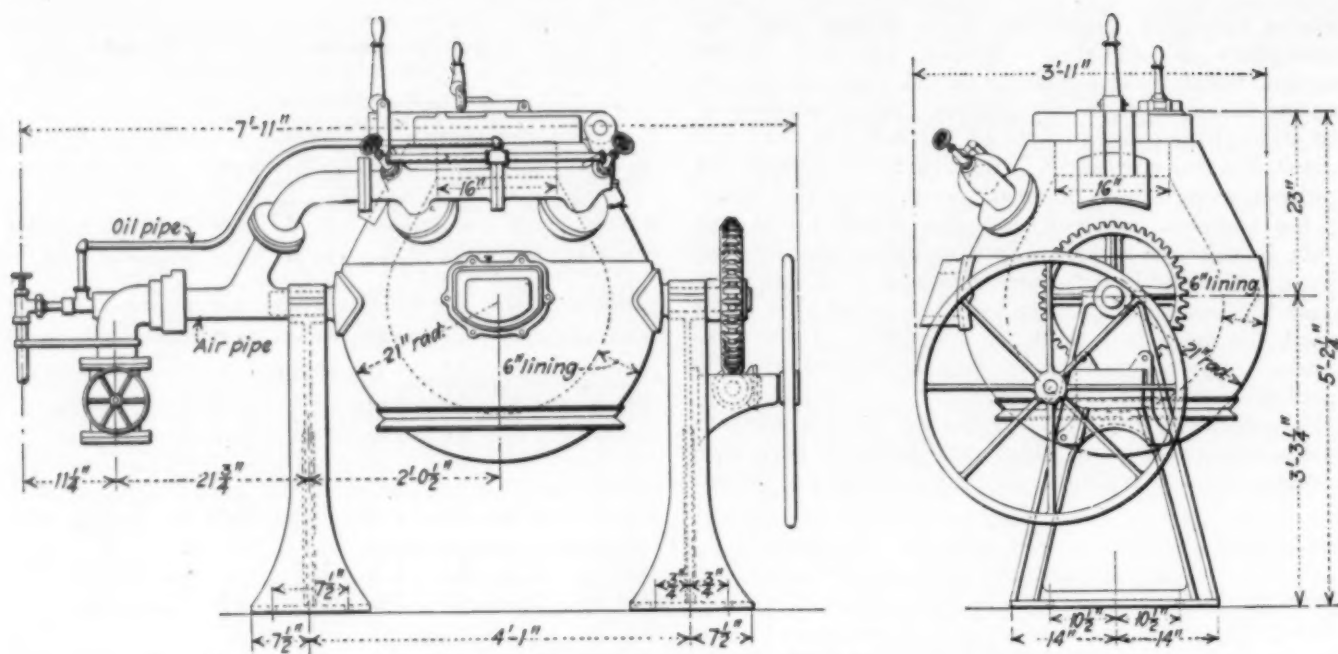


FIG. 5. SCHWARTZ FURNACE

small limits. The atmosphere as found would not be considered as oxidizing unless there is a reaction between carbon dioxide and aluminum at moderate temperatures (700-900 deg. C.).

OPEN-FLAME, TILTING, EGG-SHAPED FURNACE

Gas samples were taken from two different open-flame, oil-fired, tilting, egg-shaped furnaces. In the first furnace (No. 2 Hawley-Schwartz) the melting was done upon the bottom of the furnace; the fuel was supplied through two burners located at one side and near the top which projected the flames down upon the metal. Combustion took place over the metal bath, and the products of combustion were discharged into the air through the open pouring spout on one side of the furnace. This furnace was about 3.5 ft. in diameter. The charging door was at the top. The sampling tube was admitted into the interior of the furnace through a

hole in the charging door and luted in place with clay. The intake end of the tube was held at a point in the approximate center of the interior and several inches above the surface of the bath. Analyses of a number of samples are given in Table VI.

The constitution of the gas atmosphere in a closed furnace of this type should remain fairly constant for a given set of operating conditions. The variations in the percentages of the various constituents as shown in the table are undoubtedly due to burner adjustments.

Methane up to 2.0 per cent was found in some of the samples. The atmosphere is a difficult one to analyze from the melting standpoint, owing to the peculiar relative percentages of the various constituents in certain of the samples. At times it was plainly oxidizing, while at others the oxygen was low and the carbon monoxide quite appreciable. In a few samples both oxygen and carbon monoxide were present.

TABLE VI. ANALYSES OF GASES IN CONTACT WITH METAL IN A TILTING, OIL-FIRED, OPEN-FLAME, EGG-SHAPED FURNACE (SCHWARTZ TYPE)

Time Sample Draw	Composition, Constituents Per Cent, by Volume						Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂ (by Difference)	Oxygen, O ₂	
Melting 67:33 Aluminum : Zinc Alloy							
12:21	11.6	4.4	1.8	0.7	79.7	1.8	Metal heating; one charge
12:26	9.6	4.1	0.6	0.5	79.8	5.4	Metal heating; one charge
12:30	10.1	6.0	1.5	0.5	79.1	2.8	Metal heating; one charge
12:36	11.6	5.7	2.2	0.6	79.9	0.0	Metal heating; one charge
12:42	11.3	6.3	2.2	0.5	79.7	0.0	Metal ready to pour; temperature about 900° C.
2:16	13.1	0.4	0.0	0.0	83.1	3.4	Another charge; metal heating
2:25	14.0	0.3	0.0	0.5	82.7	2.5	Metal heating
2:30	12.3	0.0	0.0	0.2	83.0	4.5	Metal heating
2:35	11.9	0.0	0.0	0.0	82.4	5.7	Metal heating
2:40	12.6	0.0	0.0	0.0	83.1	4.3	Metal heating
2:45	12.6	0.0	0.0	0.0	83.1	4.3	Metal heating
Melting 95:5 Aluminum : Magnesium Alloy							
1:29	14.3	0.6	0.0	0.0	82.9	2.2	Another charge; metal heating
1:34	13.7	0.4	0.0	0.0	82.7	3.2	Metal heating
1:44	11.2	6.9	2.4	0.4	79.1	0.0	Metal ready to pour
3:06	13.0	0.3	0.0	0.0	83.1	3.6	Another charge; metal heating
3:11	14.7	1.8	0.0	0.0	83.4	0.1	Metal heating
3:16	12.5	2.0	0.2	0.4	82.4	2.5	Metal heating
3:24	12.8	3.9	0.7	0.3	82.2	0.1	Metal heating
Melting No. 12 Alloy							
12:24	13.3	0.0	0.0	0.0	83.4	3.3	Another charge; metal heating
13:30	14.5	1.9	0.7	0.0	82.9	0.0	Metal heating
12:34	13.7	3.1	1.1	0.1	81.9	0.1	Metal heating
12:38	12.4	3.4	1.0	0.2	81.9	1.1	Metal ready to pour
2:11	12.6	4.5	1.7	0.5*	80.0	0.3	Another charge; metal heating
2:15	13.3	3.5	1.5	0.3*	81.0	0.0	Metal heating
2:18	9.3	5.9	1.7	1.7	78.7	2.7	Metal heating
2:22	8.9	7.9	4.3	2.0	75.3	1.6	Metal heating
2:26	9.9	7.8	4.7	0.7*	76.3	0.2	Metal heating
2:30	7.2	7.3	2.5	0.3	77.0	5.7	Metal heating
2:34	7.8	11.0	7.1	0.8	73.3	0.0	Metal ready to pour.

* 0.4 per cent unsaturated hydrocarbons.

TABLE VII. ANALYSES OF GASES IN CONTACT WITH METAL IN AN INDIRECT-ARC, ROCKING, ELECTRIC FURNACE (DETROIT TYPE)

Time Sample Drawn, A.M. and P.M.	Composition, Constituents Per Cent, by Volume					Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂ (by difference)	Oxygen, O ₂
10:54	3.0	40.3	8.1	0.3	48.3	0.0
10:59	3.0	42.8	6.6	0.4	47.2	0.0
11:07	3.6	40.0	5.7	0.6	50.1	0.0
11:18	3.6	35.2	4.5	0.7	55.8	0.2
11:24	0.8	30.4	5.2	0.8	62.5	0.3
11:29	0.7	27.4	4.2	0.5	67.2	0.0
11:34	0.4	24.3	2.8	0.8	71.6	0.1
11:39	1.5	21.5	2.2	0.9	73.4	0.5
11:45	4.3	11.5	0.5	0.9	82.6	0.2
11:50	3.0	5.9	0.0	0.9	87.8	2.4
11:55	6.4	5.2	0.0	1.1	87.1	0.2
12:00	0.2	15.8	3.0	0.4	80.6	0.0
12:12	0.3	5.9	3.4	0.1	90.3	0.0
12:18	0.6	3.0	3.3	0.0	92.8	0.3
12:23	0.7	1.5	2.5	0.4	94.9	0.0
1:29	8.4	21.5	4.0	0.6	65.5	0.0
1:35	7.8	22.4	4.2	0.4	65.2	0.0
1:41	4.6	22.7	3.7	0.5	68.3	0.2
1:46	2.4	22.0	3.8	0.6	71.2	0.0
1:53	0.4	25.4	4.0	0.6	69.6	0.0
1:59	0.5	27.6	3.5	0.6	67.4	0.4
2:04	0.7	23.7	3.9	0.6	71.1	0.0
2:10	1.5	16.0	2.8	0.8	78.8	0.1
2:15	0.6	18.8	3.4	0.2	76.7	0.3
2:20	0.3	19.9	3.5	0.5	75.6	0.2
2:26	0.5	16.0	3.4	0.2	79.9	0.0
2:30	1.1	16.5	1.9	0.8	79.2	0.5

INDIRECT-ARC, ROCKING, ELECTRIC FURNACE

Gas samples were taken from an indirect-arc, rocking, electric furnace (Detroit type), of 2,000 lb. brass capacity (Fig. 6). The general features of this furnace as used for non-ferrous metal melting are well known and detailed description is not necessary here.² The charge is put in through a door at the side and melted by the heat of the arc from a pair of electrodes centered horizontally in the furnace. Any gases present in the interior of the furnace are in intimate contact with the metal, but the atmosphere is doubtless fairly uniform throughout, since ingress of air or egress of gases does not take place when the furnace is tight.

The sampling tube was projected 15 in. into the furnace through the pouring spout and luted in place with clay. It was not attempted to hold the intake end close to the liquid metal surface.

Analyses of a number of samples are given in Table VII. The furnace was run on No. 12 alloy, made up with aluminum pig plus 50:50 copper-aluminum alloy in most of the heats.

²"A Rocking Electric Brass Furnace," by H. W. Gillett and A. E. Rhoads, CHEM. & MET. ENG., vol. 18, p. 583 (June 1, 1918).

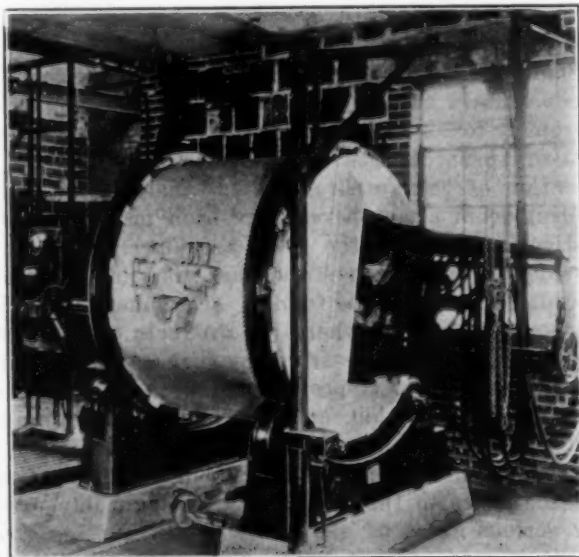
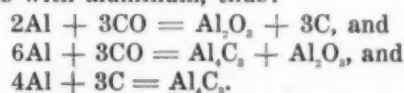


FIG. 6. DETROIT ROCKING FURNACE

The original atmosphere, immediately after charging, should consist of unaltered air. With the arc on and the furnace in operation, the oxygen will combine with the carbon of the electrodes with the formation of carbon dioxide. Then, with the oxygen used up, the carbon dioxide is reduced by the hot carbon with the formation of carbon monoxide. During the greater part of a melting period the furnace atmosphere may be expected to be high in carbon monoxide. Referring to the data given in the table, it will be seen that the carbon monoxide content of the atmosphere was generally quite high. For a short melting period between 11:08 and 12:20 (not included in the table) the range of composition was as follows: 21.0 to 39.3 per cent carbon monoxide, 0.0 to 2.7 per cent CO₂, 50.5 to 72.6 per cent nitrogen, 0.0 to 5.1 per cent oxygen; 0.1 to 3.0 of methane; 0.4 to 7.0 per cent of hydrogen, and 0.0 to 2.1 of cyanogen.

Over a long melting period, as covered by samples taken from 10:54 to 12:23 inclusive, changes in the constitution of the atmosphere were marked. Thus, carbon monoxide and hydrogen generally become less with longer duration of the melt. Carbon monoxide possibly reacts with aluminum, thus:



No analyses were made of the dross obtained on melting aluminum alloys in this furnace, but it should show aluminum oxide, aluminum nitride and aluminum carbide. Cyanogen was smelled throughout, but was not found on analysis. It is due to the direct union of carbon and nitrogen at the temperature of the electric arc. The source of the hydrogen is unknown, although a small part of it may be evolved from the aluminum on melting. Taken by and large, the atmosphere of this furnace after the arc has been on for a short time will be high in carbon monoxide and nitrogen and low in carbon dioxide and oxygen. Such an atmosphere appears to oxidize aluminum; it would, of course, be reducing to copper and zinc.

GRANULAR-RESISTOR ELECTRIC FURNACE

Gas samples were taken from a granular-resistor electric furnace (Baily type) with capacity of 1,500 lb. brass. (Fig. 7.) The general features of this furnace



FIG. 7. BAILY GRANULAR-RESISTOR FURNACE

as used for non-ferrous metal melting are well known.³ The charge is melted upon a bottom by the reflected heat from the granular carbon resistor placed in a circular trough above the hearth. If luted tightly, there should be no ingress of air. The actual atmosphere may vary at different points.

The sampling tube was admitted to the interior of the furnace through the pouring spout, and the intake end was held at a point about 1 in. above the metal surface and in about the center of the furnace. Analyses of a number of samples are given in Table VIII. The furnace was run on No. 12 alloy, the charge con-

further because the temperature is not so high as in an arc furnace, it might be expected that the carbon dioxide would be higher and the carbon monoxide lower in the granular-resistor than in the arc furnace.

The drosses obtained from the indirect-arc and the granular-resistor electric furnaces appear to be entirely different in character. No aluminum carbide is thought to be present in the dross from the latter, and evidently the temperature is not sufficiently high to cause interaction of aluminum and carbon monoxide.

DISCUSSION OF THE RESULTS; TOXICITY OF GASES

In considering the detailed analytical data given in the tables, it is of interest to note that the constitution of the gas atmosphere in a metal-melting furnace may be, and usually is, quite variable during a melting period. During a day's run in a foundry, the gas atmosphere in a furnace may be exceedingly variable. In oil- and gas-fired, open-flame furnaces, the firing conditions vitally affect the constitution. It is extremely speculative to attempt to state why a furnace atmosphere should contain certain percentages of the different constituents at a particular moment, and the authors will not attempt to present a detailed analysis of the data as set forth in the tables. As has been stated previously, the main object of the study was to determine the actual constitution of the gas atmospheres in contact with metal in typical industrial furnaces used for melting light aluminum alloys in foundry practice. The fact that the effects of most of the constituents of the gas atmospheres upon the properties of aluminum and its light alloys are largely unknown makes any discussion of this aspect of the subject speculative.

TABLE VIII. ANALYSES OF GASES IN CONTACT WITH METAL IN A GRANULAR-RESISTOR, ELECTRIC FURNACE (BAILY TYPE)

Time Sample Drawn	Composition, Constituents Per Cent, by Volume						Remarks
	Carbon Dioxide, CO ₂	Carbon Monoxide, CO	Hydrogen, H ₂	Methane, CH ₄	Nitrogen, N ₂	Oxygen, O ₂	
12:00	16.9	5.2	0.1	0.4	76.9	0.5	Metal heating
12:06	19.6	0.9	0.0	0.1	78.4	1.0	Metal heating
12:15	17.8	5.0	0.5	0.0	76.2	0.5	Metal heating
12:25	14.6	12.4	4.8	0.0	67.8	0.4	Metal heating
12:30	14.2	15.2	5.4	0.3	64.6	0.3	Metal heating
4:41	14.0	0.5	0.0	0.2	84.5	0.8	New charge
4:46	13.1	4.4	1.5	*	80.0	0.7	Metal heating
4:56	12.7	5.6	0.3	0.4	80.5	0.5	Metal heating
5:00	13.9	5.1	1.2	0.2	79.4	0.2	Metal heating
5:04	12.7	9.0	3.1	0.2	74.8	0.2	Metal heating
5:09	13.8	5.8	1.6	0.1	77.8	0.9	Metal heating
5:13	14.4	2.9	0.7	0.1	80.2	1.7	Metal ready to pour
12:03	19.9	2.9	0.3	0.1	76.4	0.4	New charge
12:08	19.9	4.3	0.1	0.1	75.2	0.4	Metal heating
12:30	13.9	13.6	4.9	0.0	66.9	0.7	Metal heating
12:36	14.2	16.6	4.7	0.1	64.2	0.2	Metal heating

* 0.3 per cent C₂H₄

sisting of No. 12 foundry scrap and aluminum pig plus 50:50 copper-aluminum alloy.

It would be expected that considerable carbon monoxide would be present in this furnace as well as in the Detroit furnace, provided the furnace is tightly closed and the melting period is sufficiently long. Referring to the data given in the table, it will be seen that the carbon dioxide content of the atmosphere was quite high, while the carbon monoxide content was variable. In a similar Baily furnace operating on brass, carbon monoxide up to 20.0 per cent was found, indicating that the reduction of carbon dioxide by carbon was more complete at the higher temperature obtaining. The oxygen content of the furnace was quite low, while hydrogen and methane were ordinarily present in small amounts. Owing to the fact that a large volume of air is contained in the furnace at the time of charging and

Some atmospheres prevailing in the melting furnaces contain carbon monoxide and cyanogen and are extremely toxic. No report of injury due to the inhalation of furnace gases in foundries have come to the attention of the authors, and no analyses of foundry melting-room atmospheres have been made in this investigation. Where the gases are discharged into the outside air through a stack, there is small possibility of contamination of the foundry atmosphere by toxic or non-toxic gases, but where the products of combustion are discharged directly from the furnace into the foundry atmosphere, it appears that a real danger exists. With good ventilation, an atmosphere containing high percentages of CO would be rapidly diluted.

Proper ventilation and suitable means for removing furnace gases to the outside air will probably prevent any serious cases of gas poisoning in melting rooms, but it is evident that even under these conditions, a man working too close may be injured.

³See CHEM. & MET. ENG., vol. 17, p. 92 (July 15, 1917); vol. 19, p. 324 (Sept. 15, 1918); vol. 21, p. 11 (July 1, 1919).

Relation of Structure to Free Alkali in Sodium Silicate Solutions*

BY WILLIAM STERICKER†

AMONG chemists there are a great many misconceptions about sodium silicate. The literature is full of contradictions and standard text-books contain many erroneous and misleading statements about it. Failure to specify the composition of the material is often the cause of the contradictions. The ratio of Na_2O to SiO_2 in sodium silicate solutions may vary from 1:1 to 1:4, although in commercial grades the limits extend only from 2:3 to 1:4.

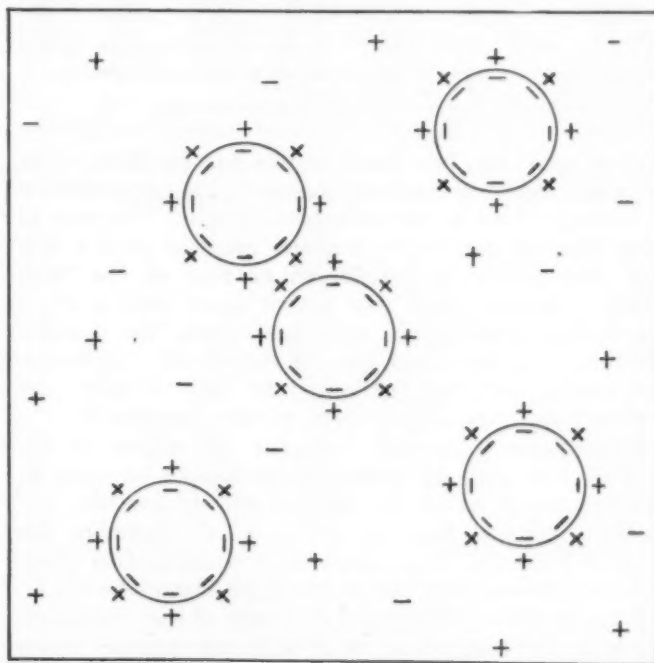
One question frequently asked is, "Do not sodium silicate solutions contain large quantities of free alkali?" The general opinion that such is the case is due to at least two reasons: (1) Sodium silicate solutions give an alkaline reaction with all common indicators. (2) Several investigators have stated that sodium silicate is completely hydrolyzed in dilute solutions.¹ Another possible reason is that some reference books² give the composition of "water glass" as $\text{Na}_2\text{Si}_2\text{O}_5$. At least one chemist has calculated that the excess of sodium oxide over that required for this formula was present as free alkali.

These facts do not afford sufficient evidence on which to base the conclusion that concentrated solutions are always largely hydrolyzed. Indicators cannot be accepted as conclusive evidence regarding the amount of free alkali. Hildebrandt³ states that "the hydrogen ion concentration at which indicators change color may be very different from the values given by Salm and others when certain substances are present." His conclusions were based on experiments by himself⁴ and by Rosenstein⁵, which showed that the presence of other materials "threw" the color change off whole powers of 10 from the tabulated values." Prideaux also calls attention to the fact that colloids and neutral salts affect the color changes of indicators.⁶ Cameron⁷ found that soils and absorbent cotton gave acid reactions with litmus even though the latter was neutral and the former yielded an alkaline extract. He concluded that the discrepancy was due to selective adsorption. These results show that the indicator method may give erroneous ideas as to the amount of free alkali present.

Furthermore, the conclusion that dilute solutions are completely hydrolyzed does not mean that the same is true of concentrated ones. In fact, it is known that salts of weak acids with strong bases are increasingly hydrolyzed on dilution.⁸ Convincing evidence of such decomposition in the case of sodium silicate was obtained by adding water to a concentrated solution. Thread-like lines immediately wriggled up through the clearly defined water layer. This showed that some material was being dissolved rapidly. This process gave

rise to a layer of flocculent material between two clear solutions. If the dilution was not too great, the flocculent material slowly dissolved when the container was shaken. But on great dilution the precipitate could not be put into solution again. Ordway⁹ showed that the precipitate salted out of sodium silicate solutions became more siliceous on dilution and concluded therefrom that the silicate was decomposed by water.

When any of the usual methods¹⁰ for the determination of the degree of hydrolysis is applied to sodium silicate solutions, it must be remembered that such solutions are colloidal and, therefore, two-phase systems. Ultramicroscopic examination proves the presence of the tiny particles which are present in the continuous phase of aqueous liquor. These particles have selectively adsorbed certain ions from the continuous phase. Since the particles move toward the positive pole when subjected to a potential gradient, it is assumed that the hydroxyl ions are adsorbed. This negatively charged particle attracts the positive sodium ions less strongly. The net result is that at the interface between the two phases there is a higher concentration of alkali than elsewhere in the system. Since the sodium ion is bound to the particle, it seems doubtful whether it can be called "free alkali." The arrangement is shown diagrammatically herewith. Possible ions other



ARRANGEMENT OF THE POSITIVE IONS AROUND THE NEGATIVE COLLOID PARTICLES

than sodium and hydroxyl are not shown. It may readily be seen that this structure will lead to inconsistent results when different methods are used to determine the degree of hydrolysis.

The structure is especially important when indicators are used, as different indicators will not be affected in the same way by the colloidal particles. Suida¹¹ has shown that hydrated silica and silicates adsorb basic dyestuffs but not acidic ones. Hence, when an acid dyestuff is used as an indicator, the alkali will be determined in the continuous phase; with a basic one, the higher concentration at the interface will be found.

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†Industrial Fellow of the Mellon Institute of Industrial Research.

¹See Vail, *J. Ind. Eng. Chem.*, vol. 11, p. 1029 (1919).

²Kohlrausch, *Z. phys. Chem.*, vol. 12, p. 773 (1893). Loomis, *Ann. Phys. Chem.*, (2) vol. 60, p. 523 (1897). Kahlenberg and Lincoln, *J. Phys. Chem.*, vol. 2, p. 77 (1898).

³T. E. Thorpe's "Dictionary of Applied Chemistry," vol. 5, p. 20 (1913).

⁴*J. Am. Chem. Soc.*, vol. 35, p. 857 (1913).

⁵*Ibid.*, vol. 30, p. 1916 (1908).

⁶*Ibid.*, vol. 34, p. 1117 (1912).

⁷"The Theory and Use of Indicators" (1917), pp. 210 et seq.

⁸"The Soil Solution" (1911), pp. 65-6.

⁹See Lewis, "A System of Physical Chemistry" (1918), vol. 1, pp. 243-5.

¹⁰*Am. J. Sci.*, (2), vol. 35, p. 185 (1863).

¹¹Lewis, *op. cit.*, pp. 247-8.

¹²*Monatsh.*, vol. 25, p. 1107 (1904).

Bogue¹² has recently pointed out that the conclusion of the previous investigators¹⁴ that sodium silicate was completely hydrolyzed in dilute solutions is open to question. Experiments with the hydrogen electrode indicate hydroxyl ion concentrations below those which would occur if there were complete hydrolysis. In one-hundredth molar solution of the commercial grades of sodium silicate, this method indicated that 1.58 to 9.27 per cent of the silicates, depending on their composition, had been hydrolyzed. The crystalline metasilicate, which is never used commercially, was 28.43 per cent hydrolyzed. The accompanying table gives the concentration of sodium hydroxide in various solutions calculated from these figures.

CONCENTRATION OF SODIUM HYDROXIDE IN SODIUM SILICATE SOLUTIONS AT 30 DEG. C.

	—Na ₂ SiO ₃ —		—Na ₂ O.118SiO ₂ —		—Na ₂ O.28SiO ₂ —	
	Silicate	NaOH	Silicate	NaOH	Silicate	NaOH
0.33 molar.....	3.70	0.1205	4.605	0.0364	5.51	0.0239
0.10 molar.....	1.22	0.0647	1.52	0.0212	1.82	0.0082
0.05 molar.....	0.61	0.0369	0.76	0.0122	0.91	0.0041
0.01 molar.....	0.122	0.0115	0.152	0.0038	0.182	0.0013
	—Na ₂ O.218SiO ₂ —		—Na ₂ O.38SiO ₂ —			
	Silicate	NaOH	Silicate	NaOH		
0.33 molar.....	6.42	0.0056	7.34	0.0042		
0.10 molar.....	2.12	0.0034	2.42	0.0029		
0.05 molar.....	1.06	0.0024	1.21	0.0019		
0.01 molar.....	0.212	0.0011	0.242	0.0008		
	—Na ₂ O.34SiO ₂ —		—Na ₂ O.48SiO ₂ —			
	Silicate	NaOH	Silicate	NaOH		
0.33 molar.....	8.245	0.0029	9.15	0.0024		
0.10 molar.....	2.72	0.0020	3.02	0.0015		
0.05 molar.....	1.36	0.0015	1.51	0.0014		
0.01 molar.....	0.272	0.0007	0.302	0.0007		

Silicate = grams of silicate of the given formula per 100 c.c. of solution.
NaOH = grams of NaOH per 100 c.c. of solution.

It will be noted that these figures are approximate percentages.

Here again the two-phase system has its effect. The hydrogen electrode probably measures the concentration of hydroxyl ions in the continuous phase. The rest of these ions are tied to the disperse phase in such a way that they cannot be considered as part of the "free alkali." As very little was known about colloids when the earlier experiments were performed, the possible effect of such structures was not considered. As Bogue has pointed out, the particles may help to carry the current¹⁵ and thus explain part of the discrepancy.

Other factors probably influence the degree of hydrolysis. In general, higher temperatures increase it. The treatment which the sodium silicate solution has received will also have an effect. If, for example, the solution is heated, then cooled, the amount of free alkali will be different than before the application of heat.

From the above discussion it is evident that the determination of free alkali is a different matter which depends on many factors. Although the hydrogen electrode is probably the best method, it is not satisfactory for all purposes, so there is no good general method. Any attempt to determine the free alkali should be carried out under as nearly the same conditions as those under which the sodium silicate is to be used. For example, if the solution is to be used for the manufacture of fiber board, the determination should be made on a sample of the solution at the average concentration and average temperature of the silicate tank on the combining machine.

To be successful, any method will of necessity take into account the factors discussed above.¹⁶

¹²J. Am. Chem. Soc., vol. 42, p. 2575 (1920).

¹³Kohrausch, Loomis and Lincoln, loc. cit.

¹⁴Based on the work of McBain and others; e.g., see McBain and Salmon, J. Am. Chem. Soc., vol. 42, p. 426 (1920).

¹⁵The development of a suitable analytical procedure of broad application now is receiving research attention at the Mellon Institute of Industrial Research.

Lead antimony alloys

Note on the Properties of Antimonial Lead

BY LOUIS J. GUREVICH AND JANE S. HROMATKO

IN CONNECTION with the investigation of the physical characteristics of lead-plates of storage batteries, it became advisable to investigate the effects of small amounts of antimony on the physical properties of lead. The following physical properties were studied: 1, temperature of melting; 2, hardness; 3, tensile properties; 4, microstructure.

The melting temperature interval of antimony-lead alloys was investigated with a view to determine the possibility of substitution of the melting point test for the chemical analysis in the determination of the composition. A series of eight alloys the antimony content of which varied from 2.76 per cent to 10 per cent were made up. The melts were made on 20-g. samples in carbon crucibles so as to keep all other impurities out of the alloys. A precision potentiometer was used to obtain the necessary data for plotting the

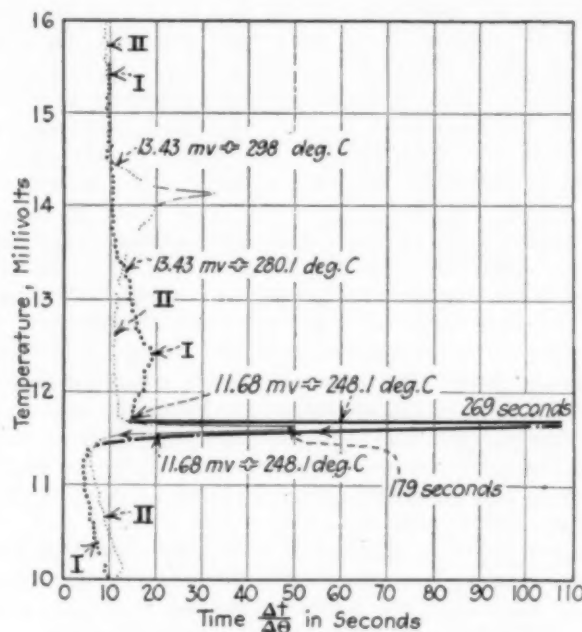


FIG. 1. INVERSE RATE COOLING CURVES.
I—ALLOY B. II—ALLOY F.

inverse rate cooling curves, as described in the authors' previous paper on "Tin Fusible Boiler-Plug Manufacture and Testing," published in the *Transactions A.I.M.E.*, vol. 152, p. 1351.

The cooling curves of the alloys indicate that no definite melting point occurs in these alloys; this can be seen from the results obtained for Table I. There is only retardation in the rate of cooling extending from the temperature of complete liquefaction, or the liquefaction point, of the alloy to the minimum or the temperature of the formation of the eutectic of the alloy. Fig. 2 shows that antimony lowers the melting point of lead to such an extent that the presence of 9.88 per cent of antimony lowers it from 327.4 to 262 deg. C. These data are similar to those obtained by previous investigators.¹ The temperature interval of melting as shown in curves I and II of Fig. 1 in the

¹"Some Notes on the Lead, Tin, Antimony Alloys," by W. Campbell and F. C. Elder, *School of Mines Quarterly*, vol. 32, p. 246.
²"Lead-Tin-Antimony and Tin-Antimony-Copper Alloys," by W. Campbell, *Proc., A.S.T.M.*, vol. 13, p. 636, 1913.

TABLE I. MELTING TEMPERATURE INTERVAL OF ANTIMONY-LEAD ALLOYS

Alloy No.	Chemical Composition Per Cent Antimony	Melting Temperature Interval, Deg. C.
A	9.88	262.0-249.0 262.0-249.0 Av. 262.0-249.0
B	8.60	280.1-248.1 273.8-249.0 276.8-250.0 Av. 276.9-249.0
C	7.68	269.7-248.7 273.8-247.2 274.3-249.0 273.8-247.2 Av. 272.9-248.0
D	6.52	279.2-247.2 282.3-250.0 261.0-249.0 Av. 280.8-248.7
E	5.42	287.2-250.0 289.9-249.0 Av. 288.6-249.5
F	4.80	295.2-248.1 298.0-248.1 Av. 296.6-248.1
G	3.94	300.8-250.0 298.9-247.2 Av. 299.8-248.6
H	2.76	310.2-247.2 310.2-248.1 Av. 310.2-247.8
Reference Lead	0	327.4

place of definite critical points, indicates that approximate results only could be obtained in calculating the composition of the alloy from the temperature of incipient fusion of the inverse rate cooling curves, the construction of which takes a considerable length of time, as each must be checked by supplementary inverse rate cooling curves. The curves in Fig. 1 are plotted with the ordinates as temperature indicated by millivolts with a copper-constantan thermocouple and the abscissæ as the number of seconds necessary for the specimen to lower by an amount equivalent to 0.5 millivolt.

HARDNESS

The hardness of the alloys used for the melting-point determination was obtained on a small dead-weight Brinell hardness machine using a 5-mm. ball and a total pressure calculated to be 42.5 kg. Table II shows that there is a gradual increase in the hardness of the alloy as the percentage of antimony present increases.

TENSILE TESTS

For the determination of the tensile properties a series of alloys were prepared containing from 3 to 25

per cent antimony. These alloys were cast in an iron chill mold in form of $\frac{1}{2}$ -in. round bar, 11 in. long, from which two standard 0.505-in. diameter specimens were prepared. The tests were made on a 20,000-lb. Olsen tensile-testing machine operated at a very low rate of speed, the pulling head moving at the rate of about 0.078 in. per minute. The results of the tests given in Table II and Fig. 3 show that the presence

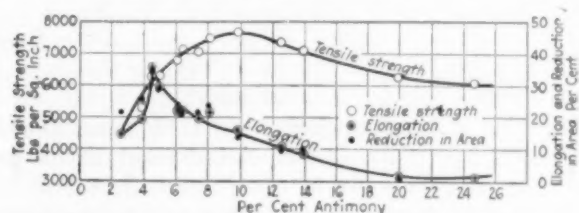


FIG. 3. TENSILE AND ELONGATION TESTS OF ALLOYS CONTAINING FROM 3 TO 25 PER CENT ANTIMONY

of antimony up to 10 per cent increases the tensile strength. Further addition of antimony decreases the tensile strength. The alloy containing 4.5 per cent antimony has the greatest amount of reduction of area, making it also the most ductile.

MICROSTRUCTURE

The second series of alloys, those used for tensile tests, were examined under the microscope after the specimens were properly prepared for the examination.

TABLE II. TENSILE PROPERTIES OF ANTIMONY-LEAD ALLOYS

Alloy No.	Chemical Composition, Per Cent Sb	Tensile Strength, Lb. Per Sq. In.	Elongation in 2 In., Per Cent	Reduction in Area, Per Cent	Brinell Hardness
Reference Lead	0	4,490	15.0	21.6	3
3	2.6	5,270	19.0	25.0	5.8
H	2.76	6,200	35.5	34.5	5.8
4	3.9	6,290	28.5	27.3	6.2
G	3.94	8,750	21.8	23.3	6.3
5	4.5	7,100	21.8	20.8	6.5
F	4.8	7,050	19.3	21.0	7.0
6	5.0	7,455	21.5	22.1	7.2
E	5.42	7,675	15.5	15.6	7.3
7	6.1	7,350	11.0	10.6	.....
8	6.4	7,025	8.8	9.3	.....
D	6.52	6,250	1.8	1.5	.....
9	7.4	6,065	1.3	0.4	.....
C	7.68	.....	.....	.....	.....
10	8.1	.....	.....	.....	.....
B	8.6	.....	.....	.....	.....
A	9.88	.....	.....	.....	.....
11	9.9	.....	.....	.....	.....
12	12.6	.....	.....	.....	.....
13	14.0	.....	.....	.....	.....
14	19.6	.....	.....	.....	.....
15	24.7	.....	.....	.....	.....

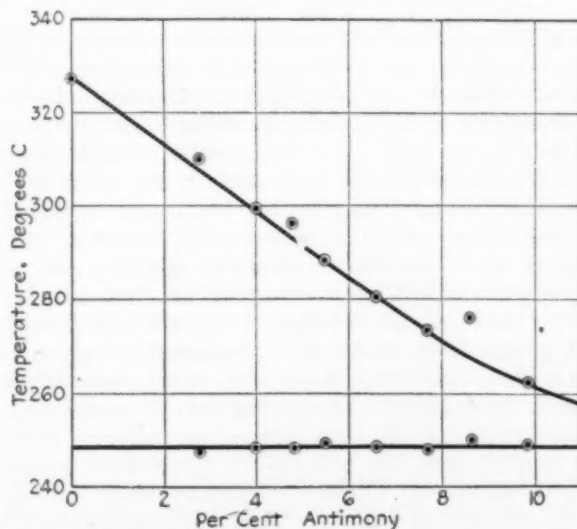


FIG. 2. EFFECT OF SMALL AMOUNTS OF ANTIMONY ON THE FREEZING POINT OF LEAD

The results of the examination corroborate the results obtained by previous investigators.² The microstructure was found to consist of a ground mass of eutectic with an excess of lead in the alloys numbered 3 to 11 inclusive of Table II. Alloy 12 showed traces of excess antimony, and the remaining alloys showed increased amounts of free antimony.

CONCLUSION

1. Melting point determinations are too indefinite to be used as a basis for calculating the composition of lead-antimony alloys.
2. The addition of antimony increases the hardness of the alloy.
3. The maximum tensile strength of the lead-antimony alloys is reached with an alloy containing 10 per cent antimony.
4. The alloy containing 4.5 per cent antimony gives the greatest reduction of area and is the most ductile.

²"Metallurgy of Lead," by H. O. Hofman, p. 26.

More Miles Per Gallon*

A Discussion on Carburetion as Affecting Motor Efficiency, Brake Horsepower and Work—Spark Timing and Brake Load—Relation Between Torque and Engine Speed—Possibilities of More Efficient Utilization of Motor Fuels

By O. C. BERRY

SO MUCH has recently been said about the possibility of fuel shortage that most of us probably have the facts clearly in mind and have formed an opinion as to what we expect to see happen. Our viewpoints will differ, however, so that there will be nearly as many opinions as there are people present, but I feel sure we can all agree that the threatened fuel shortage will not take place this year nor next and that we can expect to experience at least the first effects of a real shortage within the next ten or fifteen years.

The past growth of the automobile industry would have been impossible had it not been for an abundant supply of cheap fuel. So rapid has been this growth that in a single generation we are consuming annually approximately four billion gallons of gasoline in the United States, and our Bureau of Petroleum Technology estimates that our known petroleum reserves are 40 per cent exhausted. We have not yet reached the point where we can expect a sharp increase in prices, however, as production is still able to keep pace with demand, and the price of any commodity tends to follow one of two standards:

When the raw material is plentiful and generally available, the price of the finished product will tend to be the cost of production plus a reasonable profit.

When the raw material is hopelessly inadequate, the price of the finished product will tend to rise until it represents all that the user is willing to pay rather than be utterly deprived of the product.

I feel safe in making the prediction that the production of gasoline in the United States will not be able to keep ahead of the demands of our growing automotive industry for as many as fifteen more years, so that the shift toward the utility value of gasoline as a measure of its price will be taking place in less than that time. We will soon see the time when any man who rides in an uneconomical car is not only paying too much for his ride and forcing up the price of fuel, but is also forcing some neighbor to stay at home for lack of the fuel he has wasted. In France at the present time gasoline is selling at \$1.90 per American gallon. What can we rich Americans expect to pay when our supply runs short?

POSTPONING THE INEVITABLE FUEL SHORTAGE

From present indications it would seem that a fuel shortage is inevitable, but there are many things we can do to postpone it and to lessen its ill effects when we are forced to face it.

We can hunt for new petroleum deposits, and thus increase our available supply of raw material.

We can learn how to cut down the present wastes in mining and storing petroleum.

We can learn how to produce more gasoline per barrel of petroleum used at the refineries.

We can learn how to make substitute fuels on a large scale and at a low price.

We can learn how to get more out of each gallon of fuel we use.

We must depend upon the mining engineer and the "wildcatter" to locate more oil deposits and upon the petroleum technologist and chemist to prevent wasting the oil during mining and storing operations. To the chemist we owe what we know about the methods of making our most effective substitutes for gasoline—benzene and alcohol—and to him we must look for our future help along these lines. The discovery of an economical method of producing shale oil or an efficient method of making alcohol from farm wastes would prove a great help. The latter would be almost a complete solution for our problem. We commend these problems to this great body of scientists.

It is my purpose not only to point out what the chemist can do to make it possible for the world to ride in automobiles, but to stimulate him to action by pointing out what the automotive engineer has done and is doing. You will be interested to know that it is possible to nearly double the miles per gallon of the American automobile. In a recent economy test in France a Voisin limousine weighing 5,300 lb. went 28.3 miles per American gallon. A Citroen car weighing 2,500 lb. went 53 miles per gallon and a 1,200-lb. Peugeot went 76.9 miles.

Contrast these figures with the performance of the average American car and you will see that our room for improvement is indeed great. Probably there is no one feature of our cars that has received less of the careful attention of our engineers in the past than has their capacity for economical running. There are no features incorporated in foreign cars for fuel economy that we do not know about and understand and I do not concede for a moment that the foreign engineer is one whit more resourceful or well-informed than the American. It is therefore up to us to look the situation squarely in the face, and recognizing the importance of fuel economy, to make a careful study of all of the factors influencing miles per gallon and to see to it that every possible improvement is incorporated in the design of our future models. With these facts in mind, I have set about making such a study and am pleased to be able to present some of the information I have got together.

CARBURETION

One of the outstanding reasons for the poor mileage of the average American car is poor carburetion, or more accurately poor carburetor adjustment. In order to make this clear it will be necessary to show

*Paper read at the Automotive Symposium, American Institute of Chemical Engineers, Detroit, Mich., June 23, 1921.

the effect of the richness of the fuel mixture on the power and economy of an engine. In studying this point, use was made of a Willys-Knight engine mounted on an electric dynamometer. The results of these tests are shown by the curves in Fig. 1. In these curves the pounds of gasoline per pound of dry air in the fuel mixture is plotted horizontally and brake horsepower and per cent thermal efficiency vertically. In carrying out these tests the throttle was arranged so that it could be securely fastened, and all of the tests were run at a constant engine speed. The gasoline was weighed to the one-hundredth part of an ounce, the air metered to the tenth part of a cubic foot, and the brake-load, speed, temperatures, etc., were carefully measured. Under these conditions and with the carburetor adjusted to give a rich and powerful mixture, the first test was run. The power, efficiency and mixture ratio were then computed and a point established on both the power and efficiency curves. The gasoline adjustment was then made slightly leaner, the brake-load adjusted to produce the correct speed and a second test was run. This procedure was repeated until the mixture became too lean to allow proper engine performance. More gasoline was then introduced each time until the mixture was entirely too rich. The mixture was

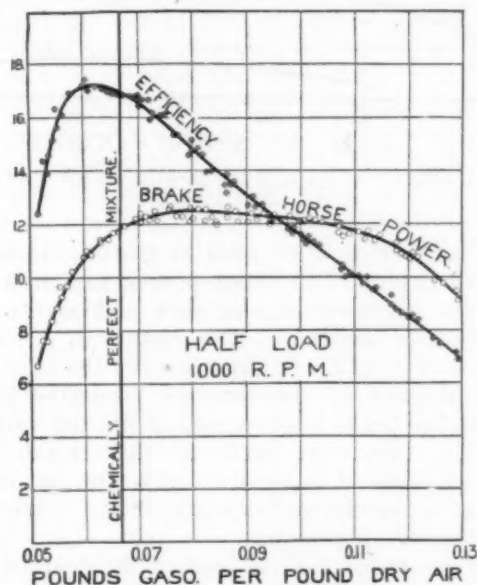


FIG. 1. EFFICIENCY AND BRAKE HORSEPOWER CURVES

thus made alternately richer and leaner until a sufficient number of points had been located on each curve to indicate quite clearly the effect of the richness of the fuel to air mixture on both the power and the efficiency of the engine.

It will be noted that there is a wide range of mixtures through which the richness has but little effect on the power of the engine. The lean and the rich mixture give equally good power and both result in what seems to be perfect engine performance. This accounts for the fact that the comparatively crude carburetors of earlier days gave quite satisfactory performance.

The range of mixtures giving the highest efficiency is very narrow, and corresponds to about the leanest mixture with which the engine will run without missing. As more gasoline is added the efficiency drops off very rapidly, so that the richest mixture producing full power will result in only about half maximum

efficiency. This explains why it is that of two cars of the same make and both performing nicely, one may go nearly twice as many miles per gallon as the other.

WHY OVER-RICH MIXTURES ARE USED

There are several reasons why so nearly all of our carburetors are adjusted so as to give too rich a mixture when the engine is hot.

Gasoline flows much more slowly when cold than when warm, so that an opening large enough to deliver the required charge to a cold engine will inevitably deliver too much when the engine is warmed up.

Cold air is denser than warm air, so that the weight of air delivered through the air opening in a carburetor will be greater when the air is cold than when it is warm, thus causing the mixture to become richer as the temperature of the engine increases.

For these reasons the mixture furnished by a carburetor with a fixed adjustment will become richer as the temperature rises. To make matters worse, not nearly all of the gasoline in a cold mixture is vaporized so that it can be burned. This makes it necessary to supply a considerable excess of fuel in a cold mixture to get the engine to run at all.

The American public has been taught to demand a car that will start easily in any kind of weather and continue to run without requiring any attention or adjusting. They have been supplied with a large variety of non-adjustable, or what has aptly been termed "foolproof" carburetors. These carburetors will deliver a mixture rich enough to start well in cold weather, and due to the great range of the explodable mixtures of gasoline and air, will keep the engine running with full power and seemingly perfectly in summer or in winter. The only fault to be found is that when the engine is hot the mixture is often 50 to 75 per cent richer than necessary and the miles per gallon are correspondingly low. A non-adjustable carburetor cannot be made so that it will make starting easy and also give high efficiency in driving.

DASH ADJUSTMENTS

A carburetor adjusted for maximum economy on a hot engine will be too lean to start when cold. There are two ways in common use for meeting this situation.

A choke may be supplied that can close off the main supply of air to the carburetor, thus enriching the mixture.

A means of adjusting the carburetor may be connected up to the dash or the steering post of the car.

The action of the choke is very severe. It causes raw gasoline to be sucked into the engine in large quantities. Its action becomes increasingly severe as the engine speeds up, so that if the mixture is rich enough to start the engine it will be much too rich after considerable speed has been obtained.

The dash adjustment may be made very satisfactory in its action if correctly used, and quite convenient as well. Its use is easily understood, as the idea is to get it set as lean as possible, and it is very easy to tell when it is too lean, as the engine will lose power and fire back through the carburetor. A proper dash adjustment set right for one speed and load will be correct at all speeds and loads at the same temperature, and will need to be changed only as the

temperature changes. The mixture should be just right for a hot engine with the dash adjustment set at its leanest position.

DISCUSSION OF CURVES

The curves in Fig. 1 show that a richer mixture is required for maximum power than for maximum efficiency. It is therefore obvious that a carburetor adjusted for maximum "miles per gallon" will be too lean to give the full power of the engine. This difficulty can be got around in this way: When driving on a level road at any speed that the law allows the engine is never called upon to deliver nearly its full power. Under these conditions the most important consideration is economy. When a steep hill is to be climbed, acceleration is desired or a neighbor wants to race, full power is the important thing. The constant speed driving is done with the throttle pretty well closed and the power work with the throttle wide open. It is possible to design a carburetor that will furnish the engine with the most economical mixture at all ordinary speeds on a hard, level road, and with the most powerful mixture when the throttle is wide open.

The fuel is almost never entirely vaporized in the intake manifold of the engine. A considerable portion flows along the manifold walls as a liquid, and lags behind the air that passed through the carburetor with it. When the engine is idling this layer of liquid is very thin, but under full load it usually forms quite a large stream. When the engine is put under load quickly, the air rushes ahead, leaving at least a portion of liquid on the manifold walls. If the mixture is lean enough to be efficient under steady running conditions, this temporary impoverishment will often be sufficient to stall the engine. It is therefore necessary to incorporate into the design of the carburetor some special means of temporarily enriching the mixture during acceleration. There are many types of construction in use, some of which are very satisfactory. It is therefore possible to get perfect acceleration even when using a mixture lean enough for maximum efficiency. The more perfect the manifold design the easier this becomes, and with the very best manifolds very little special provision is necessary for acceleration.

THE IDEAL CARBURETOR

In my estimation the highest type of carburetor yet developed for our American gasoline will meet the following requirements:

It will furnish the engine with the most efficient mixture when the car is driven at a constant speed on a hard, level road.

It will furnish the engine with the most powerful mixture when the throttle is wide open.

It will make perfect acceleration possible, even when adjusted for maximum economy.

It will have a dash adjustment that will make starting and warming up an easy matter, even in the coldest weather.

There are carburetors on the market meeting all of these requirements. They make much better "miles per gallon" possible, as well as being more satisfactory to handle than the cruder "foolproof" varieties.

THE TIMING OF THE SPARK

The second factor influencing the economy of the automobile is the timing of the spark. If the spark

passes too early it will lessen the power of the engine and tend to produce what is called a "spark" knock. If it passes too late it will also reduce the power of the engine. The proper timing of the spark in any given engine will vary with two things—the load the engine is carrying and the speed at which it is running. The latter fact is pretty generally understood, and nearly everybody knows that the faster an engine runs the earlier the spark must pass to give best results. The former fact has received comparatively little attention and will therefore be enlarged upon at this time.

In making a study of this point an engine was mounted on an electric dynamometer in such a way that the exact time of the passing of the spark could

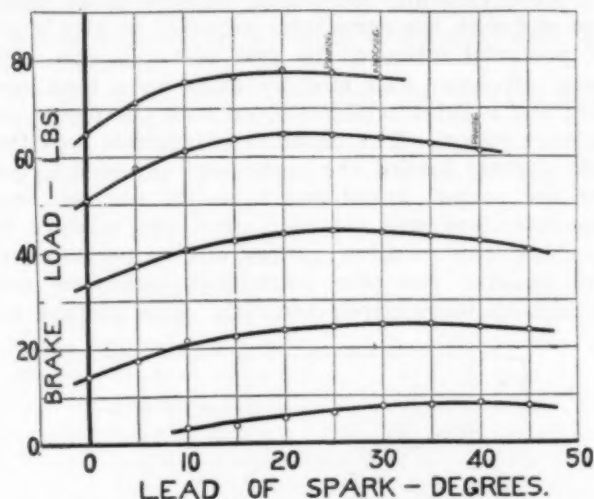


FIG. 2. DEGREES ADVANCE OF SPARK OVER FLYWHEEL AND BRAKE-LOAD

be read, as well as the speed of the engine and the brake-load carried. The engine was run at a series of different spark settings at each of a series of different throttle openings. The results of these tests are shown in Fig. 2. In these curves the lead of the spark in degrees on the flywheel is plotted horizontally, and the brake-load carried is plotted vertically. All of the tests were made at 1,000 r.p.m. Each curve was made at a constant throttle opening, the brake-load being changed along with the spark timing to keep the speed constant.

It will be noted that a lead of 20 degrees is required for maximum power at full throttle, and a lead of 25 degrees will result in a knock. As the throttle is gradually closed the lead required for highest power is gradually increased until with the lightest load carried, a lead of 40 degrees is required. At this throttle opening the engine will carry only 60 per cent as much load with a 20 degree spark lead as it does with a 40. It is so disagreeable to have an engine knocking during acceleration and hill climbing that the spark is almost never advanced beyond the point where knocking occurs at full load. Since the engines in our American cars run at such a low per cent of their power capacity, the spark is timed much later than it should be for greatest economy, resulting in a considerable loss in miles per gallon.

The vacuum in the intake manifold of an engine varies in almost inverse ratio with the brake-load carried. It therefore follows that the lead required by the spark at a light load beyond that required at full load will vary directly with the intake manifold vacuum. This fact has been made use of in produc-

ing an automatic device for changing the time of the spark to correspond to the load carried. This device, when properly installed together with a standard controller compensating for speed, provides a completely automatic means of timing the spark that is very accurate. This device is not on the market at the present time, but I have personally conducted a series of tests showing its merit, and feel confident that it will be perfected and presented to the public in the near future. When properly installed it should add considerably to the economy obtained by the average driver.

THE LOAD ON THE ENGINE

Another opportunity to improve the economy of our automobiles has to do with the large reserve power in the engines. A good American car can climb a steep hill in high gear, and accelerate very rapidly.

This delightful "activity" necessarily means that under ordinary driving conditions on a hard, level road the engine is called upon to exert a very small per cent of its full torque capacity. In order to get accurate information on this point, a car was chosen of a make known to be carefully designed, well built and a good average accelerating ability, about 3.2 ft. per sec. per sec., and tests were made showing the torque capacity of the engine and the power required to propel the car at varying speeds. The results of these tests may be taken as representing the average performance of good American cars.

The method of conducting the tests was to insert between the carburetor and intake manifold a plate having a hole drilled through it that would serve as a throttle opening. A determination was then made of the maximum speed the car could attain on a long stretch of hard, level road with this orifice in place. This test was repeated with a number of orifices of different sizes. With the engine removed from the

at that speed with that orifice, as shown by the dynamometer tests. The results of these tests are shown in Fig. 3. In these curves the engine speed is plotted horizontally and the brake-load is at a radius of 15½ inches vertically. The upper curve shows the torque capacity of the engine and the lower the torque measured at the flywheel of the engine that is required to propel the car at corresponding speeds. The distance between the upper and lower curves is therefore proportional to the reserve power of the engine and represents its ability to accelerate rapidly or climb a steep hill.

In this particular car an engine speed of 1,000 r.p.m. corresponds to twenty miles per hour. It will be noted that at this speed only about 14.7 per cent of the torque capacity of the engine is used when driving on a good road. Any one familiar with the performance characteristics of an engine knows that this fact alone will account for a large reduction in the thermal efficiency obtainable from the engine under ordinary driving conditions. This is such an important consideration that a special series of tests was carried out to show the exact situation.

EFFICIENCY AT DIFFERENT LOADS

It is well known that the brake thermal efficiency of an engine varies from zero at no load to a maximum which occurs at a little less than full load. Engines differ in their ability to perform under different conditions, according to their design, some doing comparatively better at light loads and others at full load. Tests were therefore carried out on the engine previously used, to determine the effect on its thermal efficiency of changing the load.

The engine was installed on the dynamometer and run at 1,000 r.p.m. and at a series of different throttle openings. At each throttle opening a series of tests was run at different carburetor settings, similar to the tests plotted in Fig. 1, and showing the mixture corresponding to highest efficiency at that throttle, together with the corresponding power and efficiency. The brake-load was expressed in terms of brake mean effective pressure, and a curve was drawn through the points showing the highest efficiency at each load. This curve is shown in Fig. 4, and indicates the maximum efficiency obtainable with this engine at each brake-load, the engine running at 1,000 r.p.m. The efficiencies will vary as the speed is changed, so that this curve should be interpreted as applying only to the one speed.

The carburetor was adjusted lean enough to give maximum economy at all loads until the throttle was wide open. After this point was reached the increases in power had to be obtained by enriching the mixture, until the full power was obtained. These richer mixtures result in reduced economy, thus causing the curve in Fig. 4 to show a decided drop as full power is approached. This curve therefore offers one more illustration of the importance of using lean mixtures when high economy is desired.

Fig. 4 shows how important it is to run the engine under a comparatively large per cent of its full load capacity. Since the miles per gallon of any car under given running conditions will vary directly with the thermal efficiency of the engine, a change in the load factor on the engine can result in greatly increased economy. This fact was checked in part by installing a different rear axle ratio and noting the

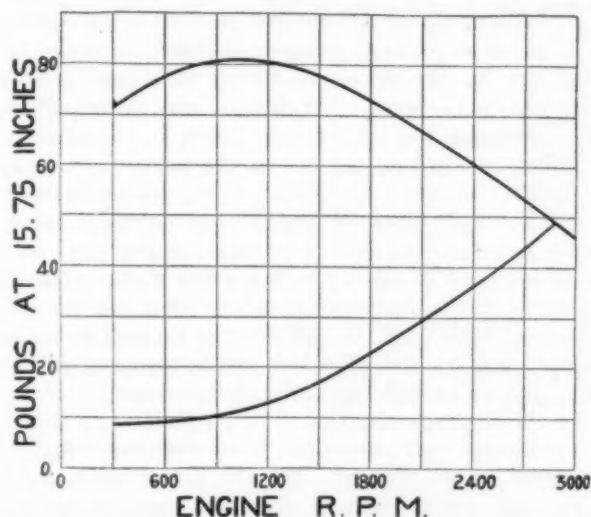


FIG. 3. RELATION BETWEEN TORQUE AND SPEED OF ENGINE

car and connected to an electric dynamometer, tests were run to determine the torque capacity of the engine at varying speeds with each of the orifices in place. Knowing the size of the rear wheels and the gear ratio, the engine speed corresponding to any car speed is accurately known. The torque required to drive the car at any one of these maximum speeds for a given orifice is the torque capacity of the engine

change in the car economy. The standard ratio was $4\frac{1}{2}$ to 1, and resulted in a load factor of 14.7 per cent at a speed of twenty miles per hour. Under these conditions the car could go 28 miles per gallon when loaded so as to weigh 3,100 lb. A gear ratio of $2\frac{1}{2}$ to 1 would result in nearly twice the former load factor, and Fig. 4 shows that this should result in

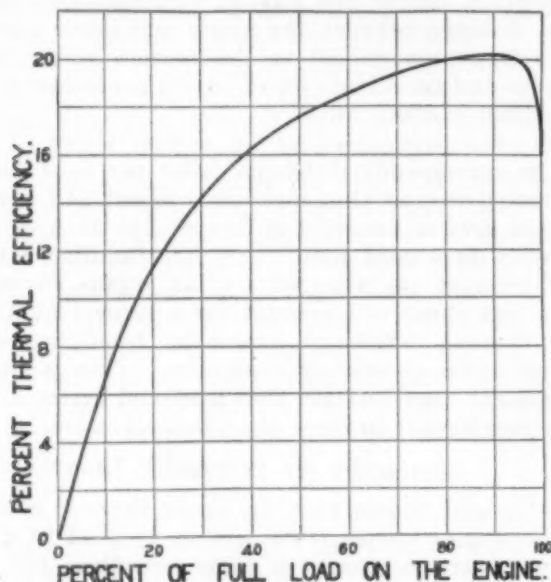


FIG. 4. EFFICIENCY OBTAINABLE AT EACH BRAKE-LOAD

an increase of about 50 per cent, or 42 miles per gallon. Under test the car actually ran 43 miles per gallon. These tests were all made with a carburetor equipped so as to make starting easy in cold weather, through the use of a dash adjustment.

ADVANTAGES AND DISADVANTAGES OF AN ADDITIONAL GEAR SPEED

Efficiency and a great ability to accelerate cannot be obtained at the same gear ratio. The former requires that the engine run at a high per cent of its torque capacity and the latter requires the other extreme. We cannot afford to compromise the delightful activity of our cars. On the other hand I feel confident that the first company to produce a car with the activity we are used to and which is also capable of going more miles per gallon than any other car of its weight in the country will become both rich and famous. We can accomplish this if we have four speeds forward. Third speed could be called the "power" or "speed" gear and the fourth the "economy" gear. Such an arrangement would be a benefit in the following ways:

It would greatly increase the miles per gallon.

It would reduce the engine vibration at the common touring speeds.

It would increase the speed at which one could tour with comfort and satisfaction on good roads.

It would enable one to tour at high speeds with the mental satisfaction that would result from knowing that one is not punishing the engine, while any other car at the same speed would be going entirely too fast for its own good.

It would greatly reduce the wear on the engine, thus prolonging its life and reducing maintenance costs.

The disadvantages are the following:

The four-speed transmission would be expensive when sufficiently well made to be quiet on two gears.

The gears would have to be shifted more often.

The possible advantages are therefore fundamental and far-reaching, and the disadvantages are of a practical nature, and though difficult, still I do not feel that they will be beyond our engineers when they really get interested in mastering them.

Our knowledge of how to increase car economy is not yet complete. There are factors influencing miles per gallon that are not mentioned here. This paper is merely a progress report presented at an early stage. I feel, however, that it has gone far enough to demonstrate the value of the study and warrant a conviction that American engineers can be depended upon to produce cars in the future showing economies that would now seem almost impossible.

In conclusion allow me to repeat that a fuel shortage in the near future is inevitable, but that its ill effects can be greatly lessened by taking the right steps at the present time. By lessening wastes in mining and storing petroleum, by perfecting the processes of making gasoline and especially by developing ways of producing substitute fuels economically and in large quantities, the chemists of the country can help make it possible for future generations to ride in automobiles. In the meantime the engineers will be steadily increasing the economy of our cars and thus adding greatly to the value of each gallon of available fuel.

Legal Notes

BY WELLINGTON GUSTIN

Company Held Not Responsible for Injury to Employee by Explosion in Gas Pipe Line

A question of negligence is decided in favor of the employer by the Supreme Court of Appeals of West Virginia in the case of Miller vs. the United Fuel Gas Co., reversing the trial court. (106 S. E., 421.)

Miller charged negligence on the part of the company in failing to keep its pipe line in a reasonably safe condition and state of repair and in permitting too great a volume of gas to remain in the pipe at high pressure; and in failing to lay a line sufficiently strong to carry with reasonable safety the volume of gas transported through it. Miller was injured by an explosion of gas in the pipe line while working about the pipe, and he brought an action for damage.

In its holdings the Court of Appeals says there was no evidence that the pipe line was improperly constructed or maintained. On the other hand, the company had constructed it only six months before the accident, and in its construction had used none but new material, obtained from La Belle Iron Works of Toledo, Ohio, the manufacturer, whose test showed a resistance sufficient to withstand a pressure of 1,500 lb. for each square inch of surface. The superintendent in charge of the work testified to its proper construction. The explosion did not occur at a coupling, but in the pipe itself, near a point where it was bent to conform to the curve of an embankment over which it ran. There was nothing to show that the pipe was improperly strained in bending or that the work was

done carelessly or negligently, but evidence to the contrary was brought out.

Failure to shut off the gas pending the search for the leak does not alone constitute negligence, because the usual way to locate a leak in one of several pipes forming part of a pipe line system is by means of the escaping gas. Though tested to withstand a pressure of 1,500 lb., the line on the day of the accident did not carry more than 350 lb.

The court said that under these facts, with the absence of any knowledge on the company's part of a fatal defect likely to cause such an accident and the failure on the part of the claimant to show by proof that it was due to some negligent act or omission to act on the part of the defendant, there is nothing to support a finding of liability against the company. The claimant was engaged on a dangerous work and well knew the risk and hazard attending it; therefore, before he can recover for the injury he must show actionable negligence on the part of the company.

When the employer has exercised reasonable care and diligence in providing a reasonably safe place within which his employees may perform the work assigned to them, he has fulfilled his duty to them in that regard. (99 S. E., 75.)

Only Attempt to Sell Goods as Another's Is Unfair Competition, *unfair*

A question of unfair competition in marketing one's product came up in the case of the Upjohn Co. vs. The William S. Merrell Chemical Co., a decree for the defendant being affirmed in the United States Circuit Court of Appeals, 269 Fed., 209.

It appears that plaintiff had marketed its product by extensive advertising and selling throughout the United States in 1908, when defendant's salesmen found the product on the market and sent in to the house samples of plaintiff's article. Defendant thereupon decided to make the same thing in the same form, with the expectation that it would thereby be able to fill with something "equally as good" a part of the demand which the plaintiff company was creating. To this end defendant put up an article which was indistinguishable from plaintiff's, but it did not use the latter's trade name or mark, and put the product up in bottles or packages bearing its own name as manufacturer.

It was not claimed that in the bottles or cartons, or anything except in the product itself, was there fraudulent imitation or unfair competition. Nor was it denied that defendant had, inherently and originally, the same right plaintiff had to select from the common stock this particular size, shape and color for its product.

WHEN IMITATION IS UNFAIR COMPETITION

The court said it was well settled by decisions of the U. S. Supreme Court that a plaintiff is entitled to relief against unfair competition only where defendant attempts to palm off on the purchasing public his goods as the goods of the plaintiff; that where the imitation relates only to matters as to which the defendant has, *prima facie*, a right equal to plaintiff, there must have been a public acquiescence in plaintiff's appropriation of these things for his product—whereby they have become indicia of origin, to make the imitation unfair competition.

That while, when the plaintiff has selected as his means of identification words or marks that are arbi-

trary and hence proper trade marks, his title is at least initiated by the appropriation; yet as to those means of identification which are descriptive or which for any reason are known and open to all there is no basis in principle or authority for the creating of a title of quasi-exclusive right in plaintiff, except the theory that there has been this public sanction of plaintiff's appropriation, by acquiescence which has continued long enough and under circumstances suitable to raise a presumption that the public concedes the right and to make it inequitable and unfair thereafter to dispute it.

The court said there were plenty of other sizes, shapes and colors than plaintiff's which defendant might have adopted; it must have copied plaintiff's complete combination because it expected to get commercial benefit from the copying. But this is not enough, says the court; to be condemned it must have expected to practice a fraud or contribute to the practicing of it.

The situation must be judged as it existed when defendant introduced his copy of the product, and the fact that plaintiff's product, whose appearance and composition were alike open to everybody, had been in the hands of distributors for a few months does not establish a sanction by the consuming public of plaintiff's appropriation of that composition and appearance for its own use and product sufficient to prevent its subsequent appropriation by the defendant.

Many cases were cited supporting the claim of unfair competition, and the court granted that each case depends so absolutely upon its own circumstances that a controlling precedent is not to be expected. Each of the cited cases upon which plaintiff specifically relies depends upon the finding that the consuming public had come to regard the trade dress as indicating that the thing was the article which it was in the habit of buying and wanted to get.

REASONING BY THE COURT

Further the court says: "Perhaps the result which we reach in this case, rested as it is upon the fact that defendant copied the product and began its competition before there was time for plaintiff to get the indicative effect of its trade dress sufficiently established, is most severely tested by saying that this would make the diligent thief immune, while the one who might hesitate and delay must give up his plunder. The answer is that there can be no larceny unless the title or possessory right of the first holder is better than that of the second taker"—and that in this case, until the general public belief among users that any product of this appearance was plaintiff's product connected with its trade name had come into existence, plaintiff's title to this combination of characteristics was no better than defendant's.

To establish unfair competition by copying the appearance of plaintiff's product, it is necessary that the appearance has received such sanction as to identify the article sold under plaintiff's trade mark or name.

As to the injustice in a state of the law which denies protection to a plaintiff who has expended \$30,000 and more in introducing to the public his peculiar form of product, the court points out that in this case the expense indivisibly inured to the advantage of the trade mark; and in any case it says it may be a lesser evil that plaintiff must fail of full protection than that free choice of common form should be denied to competitors. No unfair competition was found.

Definitions of Physical Terms

BUREAU OF STANDARDS Circular 100, on "Nickel," (published in large part serially in *CHEMICAL & METALLURGICAL ENGINEERING*, beginning Jan. 5, 1921) contains the following definitions of physical constants. These have often been determined for various metals and alloys:

Absorption Index.—When monochromatic light traverses a distance equal to its own wave length, λ , in a material, is the ratio of the amplitude of the emergent light J'_λ to that of the entering light J_λ .

$$\frac{J'_\lambda}{J_\lambda} = e^{-2\pi\kappa}$$

when κ is the absorption index.

(A variety of usage prevails regarding the definition of this term. This definition is used in the Smithsonian physical tables.)

Density.—The density of a substance is the mass per unit volume. It is usually expressed in terms of grams per cubic centimeter.

Electrical Conductivity and Resistivity (χ , ρ).—There are two methods of expressing electrical resistivity in common use, each being defined quantitatively in terms of the resistance of a unit specimen. The volume resistivity is ρ in the equation

$$R = \frac{\rho l}{s}$$

in which R = resistance, l = length, and s = cross-section. The volume resistivity thus defined may be expressed in various units, such as microhm-cm. (microhm per centimeter cube), ohms per foot of a uniform wire 1 mil in diameter, etc. The commonly used units, in abbreviated terminology, are: Microhm-cm., microhm-inch, ohm (meter, mm.), ohm (meter, sq.mm.), ohm (mil, foot).

The other kind of resistivity is mass resistivity, and is defined as δ in the equation

$$R = \frac{\delta l^2}{m}$$

in which m = mass of the wire. The usual units of mass resistivity are: ohm (meter, gram), and ohm (mile, pound).

Per Cent Conductivity.—The term "conductivity" means the reciprocal of resistivity, but it is used very little in wire calculations. In connection with copper, however, extensive use is made of the per cent conductivity, which is calculated in practice by dividing the resistivity of the international annealed copper standard at 20 deg. C. by the resistivity of the sample at 20 deg. C.

Temperature Coefficient of Resistance.—The temperature coefficient of electrical resistance is the fractional change of resistance per degree change of temperature. Its value varies with the temperature, and hence the temperature from which the resistance change is measured must always be stated or understood. For a temperature t_1 , the temperature coefficient α_1 is defined, for a metal like copper, by

$$R_t = R_{t_1}[1 + \alpha_1(t - t_1)],$$

in which R_{t_1} = resistance at the temperature t_1 , and R_t = resistance at any other temperature t . The temperature coefficient that is usually used at 20 deg., for example, is

$$\alpha_{20} = \frac{R_t - R_{20}}{R_{20}(t - 20)}$$

Boiling Point.—The boiling point of a liquid is the

temperature at which it boils under atmospheric pressure, or better the temperature at which its vapor pressure is equal to the external pressure.

Brinell Test.—An indentation is made, by pressure, on a polished surface of the material, using a hardened steel ball. There are several ways of expressing the hardness:

The commonest definition of the Brinell hardness is the pressure in kilograms per unit area (square millimeters) of the spherical indentation. (Hardness numeral = H. N.)

$$H. N. = \frac{\text{Pressure}}{\text{area of spherical indentation}} = \frac{P}{t\pi D}$$

$$\text{where } t = \frac{D}{2} - \sqrt{\frac{D^2}{4} - \frac{d^2}{4}}$$

P = pressure used;

t = depth of indentation;

D = diameter of sphere;

d = diameter of indentation.

Electrolytic Solution Potential (E).—At the junction of a metal and any conducting liquid there is developed a solution potential, which is a measure of the free-energy change of the chemical reaction which is possible at the surface of the metal and liquid. In particular if the chemical reaction consists in the solution of the metal, forming ions, the e.m.f. is

$$E = \frac{RT}{nF} \ln \frac{P}{p}$$

where R = the gas constant;

T = absolute temperature;

n = valence of metal;

F = 96,500 coulombs, the Faraday constant;

P = solution pressure of metal;

p = osmotic pressure of metal ion formed in solution.

In any electrolytic cell the sum or difference of two such potentials is measured, one of which may be a standard electrode; for example, the hydrogen or the calomel electrode. The e.m.f. of an electrolytic cell of the following type: Normal hydrogen electrode—solution—metal is often called the single e.m.f. (e_h) for the metal in the solution; that is, arbitrarily assuming the e.m.f. of the normal hydrogen electrode to be zero.

Emissivity (E or E_λ).—The coefficient of emissivity

E for any material represents the ratio $\frac{J'_\lambda}{J_\lambda}$ of the intensity, J'_λ , of radiation of some particular wave length or color, λ , emitted by the material at an absolute temperature T to that J , emitted by a black body radiator at the same temperature.

The coefficient of total emissivity E for any material represents that ratio $\frac{J_t}{J}$ of the intensity of radiation of all wave lengths, J_t , emitted by the material at an absolute temperature, T , to that, J , emitted by a black body radiator at the same temperature.

This coefficient is always less than 1, and for metals is equal to 1 minus the reflection coefficient for normal incidence (Kirchhoff's law).

For any optical pyrometer using monochromatic light a value of the observed or "black body" temperature of any substance (not inclosed) is reduced to the true temperature by the following formula:

$$\frac{1}{T} - \frac{1}{T_0} = \frac{\lambda \log E_\lambda}{6232}$$

where T = true absolute temperature;

T_o = observed absolute temperature;

λ = wave length in microhm (0.001 mm.);

$E\lambda$ = relative emissivity of substance for wave length.

Erichsen Test.—This test is carried out to determine the ductility of sheets. An indentation is made in the sheet with a die with hemispherical end. The greatest depth of indentation which can be made without incipient cracking of the sheet, measured in inches or millimeters, is known as the Erichsen value for the sheet.

Heat of Fusion.—The heat of fusion of a substance is the quantity of heat absorbed in the transformation of unit mass (1 g.) of the solid substance to the liquid state at the same temperature.

Magnetic Properties.—The usual magnetic characteristics of a substance are given either by the permeability, μ , or the susceptibility, κ . Permeability is the ratio of the magnetic induction (B in gaussess per square centimeter) to the magnetizing force (H in gaussess per square centimeter). This is indicated by the relation

$$\kappa = \frac{B}{H}$$

Susceptibility is given, in corresponding units, by

$$\kappa = \frac{\mu - 1}{4\pi}$$

For all materials except iron and a few other ferromagnetic metals μ is very nearly unity and κ is only a few millionths. When κ is positive in sign the substance is paramagnetic, when negative diamagnetic. The susceptibility as thus defined is sometimes called volume susceptibility and indicated by κ_v . A quantity called mass susceptibility is also used, and is equal to the volume susceptibility divided by the density of the material; it is represented by κ_m .

Melting Point.—The melting or fusing point of a substance is the temperature at which it fuses (under atmospheric pressure), or more accurately the temperature at which the solid and the liquid metal are in equilibrium with each other.

Peltier Effect (π).—When at the junction of two metals current flows from one to the other, heat is in general absorbed or liberated (see "thermoelectromotive force" below); the coefficient, the amount of heat liberated when a unit quantity of electricity flows across the junction, is known as π (measured either in calories per coulomb or in volts), the Peltier effect.

Refractive Index.—The ratio of the velocity of light in vacuum to that in any material is called the refractive index (n) of that material. (This physical quantity ceases to have a meaning at or near an absorption band in the material.)

Scleroscope Test (Shore).—A hardened hammer falls from a constant height onto a polished surface of the material, and the distance of rebound is measured on a scale 10 in. long, divided into 140 equal parts. The scleroscope hardness is expressed as the distance of rebound on this arbitrary scale, the value 100 representing the hardness on this scale of hardened steel.

Specific Heat.—(σ).—The true specific heat of a substance is $\frac{du}{dt}$ when u is the total internal heat or energy of unit mass of the substance. The mean specific heat is defined as $\frac{q}{t_1 - t_2}$ per unit mass when q is the quantity

of heat absorbed during a temperature change from t_2 to t_1 . It is generally considered as the quantity of heat (calories) required to raise the temperature of unit mass (grams) by unity (degrees centigrade), either at constant volume or at constant pressure. Unless otherwise noted the specific heat of solids refers to that at constant (atmospheric) pressure. The true specific heat (constant pressure) of metals may usually be expressed sufficiently by an equation of the type

$$\sigma = A + Bt + Ct^2 + \dots$$

Tensile Test.—The quantities determined in the tension test are the following:

The *ultimate tensile strength* is the maximum load per unit area of original cross-section borne by the material.

The *yield point* is the load per unit of original cross-section at which a marked increase in the deformation of the specimen occurs without increase of load.

The *elastic limit* is the greatest load per unit of original cross-section which does not produce a permanent set.

The *proportional limit* is the load per unit of original cross-section at which the deformations cease to be directly proportional to the loads.

The *percentage elongation* is the ratio of the increase of length at rupture between arbitrary points on the specimens to this original length.

The *percentage reduction of area* is the ratio of the decrease of cross-section at the "neck" or most reduced section at rupture to the original section.

Thermal Conductivity (λ).—The coefficient of thermal conductivity (λ) expresses the quantity of heat (small calories) which flows in unit time (seconds) across a unit cube (centimeter) of the material whose opposite faces differ in temperature by unity (1 deg. C.). Its *temperature coefficient* is expressed as

$$\alpha_{t_0} = \frac{\lambda_t - \lambda_{t_0}}{\lambda_{t_0} (t - t_0)}$$

Thermal Expansion.—If l_t is any linear dimension of a solid at any temperature $\frac{dl}{dt}$ is the linear coefficient of thermal expansivity of that solid in the direction of l . It is not in general proportional to the temperature except approximately over small temperature intervals, but may be expressed in the following manner:

$$\frac{dl}{dt} = a + bt + ct^2 \dots$$

For small temperature intervals a mean coefficient (α) is often determined; that is,

$$\alpha_{t_0} = \frac{l_t - l_0}{l_0 (t - t_0)}$$

Thermoelectromotive Force (E).—In an electric circuit composed of two dissimilar conductors, the two junctions being at different temperatures, there exists in general an electromotive force, called the thermoelectromotive force, between the two metals, the value of which is a function both of the temperature and the difference of temperature between the two junctions. It is shown thermodynamically that this e.m.f. is related to the Thomson and Peltier effects in the following manner:

$$\pi = \left. \frac{T dE}{J dt} \right\} \text{and is expressed in calories per coulomb when}$$

$$\sigma_1 - \sigma_2 = - \left. \frac{T d^2 E}{J dt^2} \right\} \quad J = \frac{418 \text{ dynes} \times 10^6}{\text{calories}}$$

when E is the thermal e.m.f., T the absolute temperature, $\frac{dE}{dt}$ the thermoelectric power (see below), and $\sigma_1 - \sigma_2$ the difference in the Thomson effect of two materials. The form of the function $E = f(T)$ is not known. In general the equation $\frac{dE}{dt} = A + BT$ satisfactorily fits the experimental data over a limited range of temperature of a few hundred degrees.

Thermoelectric Power.—If E is the thermoelectromotive force of any two dissimilar metals, $\frac{dE}{dt}$ = the thermoelectric power; it is at any temperature therefore approximately the thermal e.m.f. of a couple of which the temperatures of the two junctions differ by 1 deg. C.

The Thomson Effect.—When a current flows in a conductor from a point at one temperature to one at another, heat is in general liberated, or absorbed, and an e.m.f. or counter e.m.f. is produced. The coefficient of the Thomson effect is the amount of heat liberated or absorbed when unit quantity of electricity flows from a point at temperature t to one at a temperature $t + dt$, and is equal to σdt calories per coulomb where σ is the so-called Thomson specific heat of electricity. It is called positive for any material when heat is generated in that material as a current flows from a region of higher to one of lower temperature.

The Oxidation of Carbon Tool Steel on Heating in Air

BY HOWARD SCOTT

Instructor in Metallurgy, Harvard University

IT IS SOMETIMES of value, from the viewpoint of both the laboratory and the shop, to know to what extent decarbonization (oxidation of carbon) and scaling (oxidation of iron) are likely to alter the structure and dimensions of carbon tool steel under heat-treatment. There seems, however, to be no systematic data in the meager literature on this subject outside of that presented by Emmons¹, who studied the effect of temperature and oxidizing medium on the depth of decarbonization. It is of perhaps equal importance to determine also the scaling and decarbonizing effect of air for various heating periods and whether the size of specimen has any effect. For this reason the experiments described here were undertaken.

The materials investigated were "Armco" iron in the form of $\frac{1}{2}$ -in. plate and a eutectoid carbon steel in the form of 1-in. round bar which gave the following analysis:

	C	Mn	Si	S	P
Armco iron.....	0.03	0.06	trace	0.021	0.004
Steel	0.86	0.51	0.04	0.040	0.024

Disks about $\frac{1}{2}$ in. thick were cut off the steel bar and ground plane and parallel to 0.001 in. on an alundum grinding wheel. One-inch square specimens were cut from the iron plate and similarly prepared. The specimens were heated in an electric muffle furnace and the duration of the heating was recorded from the time at which they reached the furnace temperature. After treatment they were cooled in lime. The scale was then chipped off the parallel faces, which were slightly re-ground until about half the surface showed metal. One-half the difference between the thickness before and after treatment was taken as the loss due to scaling.

TABLE I. EFFECT OF TEMPERATURE AND TIME ON THE SCALING AND DECARBONIZATION OF CARBON TOOL STEEL

Temperature, Deg. C.	Time, Hr.	Scaling, In.	Decarbonization, In.
780	2	0.001	0.000
780	5	.002	.000
890	$\frac{1}{2}$	0.001	0.000
890	$\frac{1}{2}$	.002	.002
890	1	.002	.004
890	2	.003	.011
890	5	0.006	.020
970	$\frac{1}{2}$	0.001	0.007
970	$\frac{1}{2}$	.002	.016
970	1	.003	.022
970	2	.006	.032
970	5	.008	.049
1,060	$\frac{1}{2}$	0.002	0.016
1,060	$\frac{1}{2}$	.003	.022
1,060	1	.006	.036
1,060	2	.012	0.058
1,060	5	.013	.081

TABLE II. RELATIVE OXIDATION OF "ARMCO" IRON AND CARBON TOOL STEEL

Temperature, Deg. C.	Time, Hr.	Iron Scaling (In.)	Steel
780	2	0.002	0.001
780	5	.004	.002
890	2	0.004	0.003
890	5	.008	.006
970	2	0.010	0.007
970	5	.014	.010
1,060	2	0.017	0.012

TABLE III. EFFECT OF THE THICKNESS OF THE SPECIMEN ON THE SCALING AND DECARBONIZATION OF CARBON TOOL STEEL

Thickness, In.	Scaling, In.	Decarbonization, In.
$\frac{1}{2}$	0.008	to center
$\frac{1}{2}$	.008	0.045
$\frac{1}{2}$	.009	.049
1	.009	.045

The steel samples were prepared for microscopic examination by cutting in half perpendicularly to the plane faces and fastening together with bolts pairs which it was desired to compare. These sections were polished and etched with 10 per cent picric acid in methanol. A sharp edge was thus more easily obtained than by electrolytic deposition of copper and the additional advantage was obtained of being able to compare two specimens in the same field.

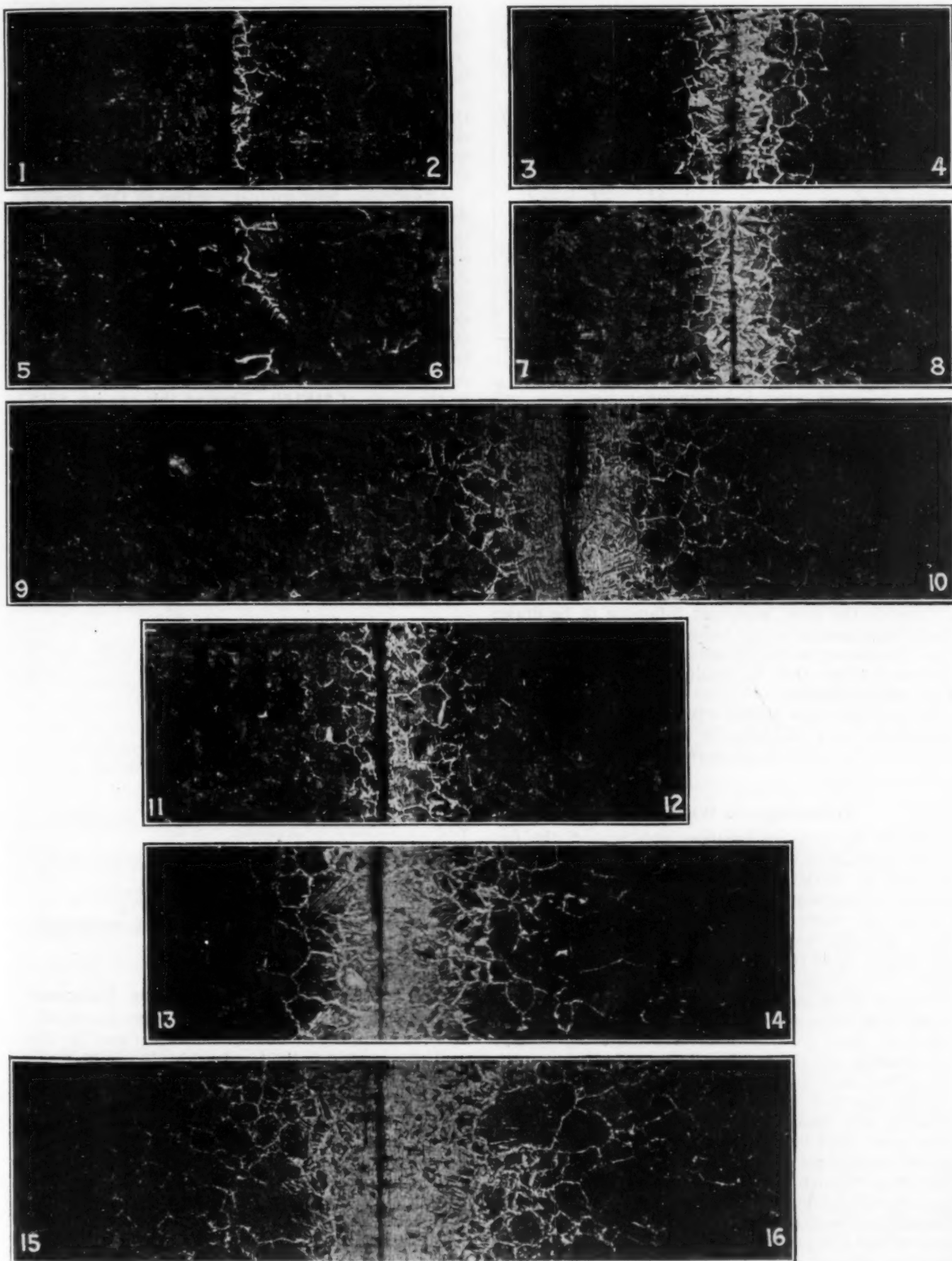
The depth of decarbonization was measured with a graduated eye-piece using a 16-mm. objective. The limit of free ferrite was somewhat irregular, so the values given are estimated averages. They are somewhat higher than those of Emmons, but this is to be expected, for he measured only to the limit of free cementite in a hypereutectoid steel.

The data obtained on the scaling and decarbonization of steel samples for various periods of heating are given in Table I and those for the scaling of iron and steel samples heated simultaneously in Table II. Table III gives the results of heating steel specimens of different thicknesses for five hours at 970 deg. C. Micrographs were also taken of representative specimens and are shown in Figs. 1 to 16.

The results for decarbonization are summarized in Fig. 17, which shows the effect of time and temperature on the depth of decarbonization as measured from the oxidized surface. The total thickness of steel affected by the oxidizing conditions is of course greater and may be obtained by adding the figures for scaling to those for decarbonization as given in the tables.

These data establish several phenomena to which attention might properly be called. First, the scaling of the "Armco" iron is greater than that of the steel under identical conditions. This is a necessary conse-

¹J. V. Emmons, *Trans., A. I. M. E.*, vol. 50, p. 405 (1915).



FIGS. 1 TO 16. DECARBONIZATION OF EUTECTOID STEEL AFTER ANNEALING AT VARIOUS TIMES AND TEMPERATURES

Figs. 1 and 2. $\frac{1}{2}$ hr. at 890 and 970 deg. C. respectively. $\times 40$. Figs. 3 and 4. $\frac{1}{2}$ hr. and $\frac{1}{2}$ hr. at 1,060 deg. C. $\times 40$. Figs. 5 and 6. $\frac{1}{2}$ hr. and 1 hr. at 890 deg. C. $\times 100$. Figs. 7 and 8. $\frac{1}{2}$ hr. and 1 hr. at 970 deg. C. $\times 10$. Figs. 9 and 10. Sample $\frac{1}{2}$ -in. and $\frac{3}{4}$ -in. thick heated 5 hr. at 970 deg. C. $\times 40$. Figs. 11 and 12. 2 hr. at 5 hr. at 890 deg. C. $\times 40$. Figs. 13 and 14. 2 hr. and 5 hr. at 970 deg. C. $\times 40$. Figs. 15 and 16. 2 hr. and 5 hr. at 1,060 deg. C. $\times 40$.

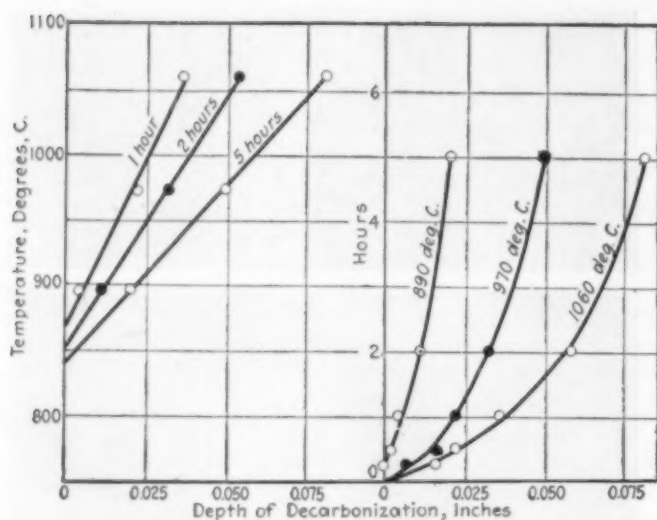


FIG. 17. RELATION BETWEEN DEPTH OF DECARBONIZATION, TIME AND TEMPERATURE

quence of the greater affinity of oxygen for carbon than for iron. Second, the size of the specimen is immaterial under the conditions of the experiment except when it is less than $\frac{1}{2}$ in. thick. Third, the same depth of decarbonization does not imply the same amount of carbon lost; thus one-half hour at 1,060 deg. C. gives the same depth of decarbonization as one hour at 970 deg. C., but the microstructure shows less free ferrite in the latter case.

Possibly the most important inference to be drawn from these results is that below about 850 deg. C. and for a period up to five hours there is no appreciable decarbonization—that is, scaling at least keeps pace with decarbonization.

In conclusion the author wishes to acknowledge the interest in this work shown by Prof. Sauveur, in whose laboratory the experiments were conducted.

Cambridge, Mass.

Outsaving the Wheelbarrow

One of the pressing business questions of the day is the elimination of industrial wastes. It is a factor that has an important bearing on the manufacturer's problem of meeting economic conditions.

Industrial waste may represent material, labor or time. Material wastes are concrete, tangible, and for this reason have received closer study. On the other hand, labor wastes and time wastes, particularly unproductive labor and time represented in the handling of material, have not, generally speaking, received the attention their importance as a definite opportunity for effecting certain economy in manufacturing justifies. That there is that opportunity has been demonstrated time and time again in specific cases. That industry as a whole, and individual manufacturers in particular, may be materially benefited through approved mechanical handling method is certain. Yet, over 90 per cent of the industrial plants in this country are still doing all or a large part of their lifting, transporting and conveying by hand labor, and it is evident that this means the annual expenditure of a tremendous amount of money, which might be used for more productive purposes.

A series of elaborate time-motion studies on the work of electric storage battery trucks vs. wheelbarrows recently made by the Yale & Towne Mfg. Co. at its Stamford, Conn., plant is a case in point.

Accurate records were first made on the cost of handling 600 tons of molding sand from a freight car on the railroad siding to the molding room in the foundry, 200 ft. away. Forty feet of this distance was a 12 per cent grade up a concrete ramp, with a sharp, right-angle turn into the shop at the top. It took eighteen men with wheelbarrows and shovels six days, working nine hours per day, to transfer the 600 tons of sand. The total cost was \$545.72.

A few weeks later another 600 tons of the same sand, delivered by car to the same point, was transferred to the molding room by means of a Yale electric truck equipped with a standard detachable end-dump body of 27 cu.ft. capacity. With one man driving the truck (one member of the former wheelbarrow gang) and an extra man with a shovel to help load the truck, this 600 tons of sand was transferred in four days, nine hours work per day, at a total cost, including interest on capital invested and charges for electric current used by the truck, of \$183.60. Thus on this one job, \$362.12 was saved. Needless to say, the mechanical way is standard practice at the plant.

The following itemized statement is interesting:

MECHANICAL METHOD

Material handled: Molding sand.	
From: Freight car.	
To: Molding room storage.	
Distance: 400 ft. round trip.	
Grade: 12 per cent, 40 ft. long.	
Capacity of Yale dump body truck: 27 cu. ft.	
Men required: To load.....	5
Men required: To unload.....	4
Men required: To operate.....	1
Total men.....	10
Total time consumed to unload shipment of 600 tons.....	4 days
Total cost of labor (9-hr. day).....	\$183.60
Demurrage charges.....	None
Total expense.....	\$183.60

WHEELBARROW METHOD

Material handled: Molding sand.	
From: Freight car.	
To: Molding room storage.	
Distance: 400 ft. round trip.	
Grade: 12 per cent, 40 ft. long.	
Capacity of wheelbarrows: 5 cu. ft.	
Men required: To load.....	3
Men with wheelbarrows.....	15
Total men.....	18
Total time consumed to unload shipment of 600 tons.....	6 days
Total cost of labor (9-hr. day).....	\$495.72
Demurrage charges (over 4 days, \$25 per day).....	50.00
Total expense.....	\$545.72

Many more examples could be cited.

Mechanical handling is one way of accomplishing more work for the same expenditure.

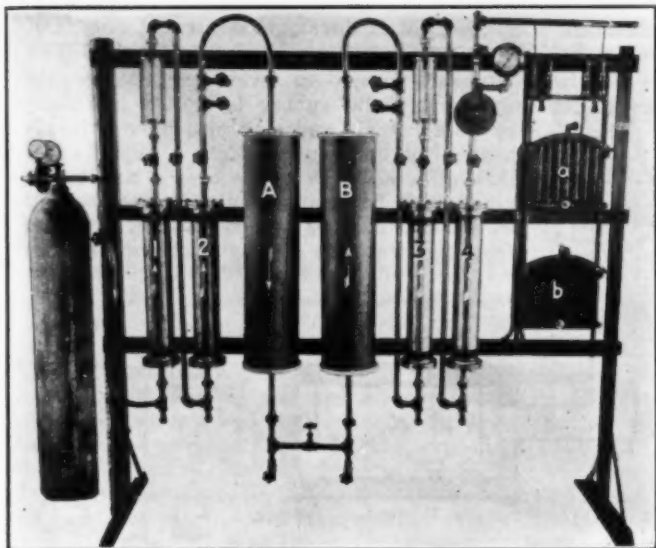
Nitrogen and Argon Gas-Purifying Equipment

The apparatus shown in the accompanying figure is used for purifying the nitrogen or argon used for filling the bulbs of electric lights. In this electric high-pressure nitrogen- and argon-purifying equipment, which is marketed by the Charles Eisler Engineering Co., of Newark, N. J., the gas to be purified under a pressure of 30 to 50 lb. per sq.in. passes through containers 1 and 2, electric furnace A, which holds a steel tubing containing copper, electric furnace B, containing copper oxide, and containers 3 and 4, whence the purified gas, after being reduced to 5 to 6 lb. per sq.in. pressure by means of a diaphragm reducing valve, enters the supply line.

The electric furnaces operate on 110 or 220 volts and take about 9.4 amperes each. They are separately controlled by the respective rheostats a and b. The temperature for purifying is between 500 and 650 deg. C.

The advantages of operating the apparatus under

Gas purification



ELECTRIC HIGH-PRESSURE NITROGEN- AND ARGON-PURIFYING EQUIPMENT

high pressure may be summarized as follows: The purifying materials react more rapidly, so that complete removal of impurities is possible, even with somewhat lower temperatures in the tubes containing the copper and copper oxide; when gas is drawn at 5-lb. pressure from purifiers operating at 40 lb. the gas is in contact with the reagents practically three times as long as when the purifiers are operated at 5 lb.; when the gas-filled furnaces are allowed to cool to room temperature the final internal gas pressure is above that of the atmosphere, so that it is impossible for air to enter the purifiers through leaks.

In starting the apparatus, from 20 to 25 minutes is required to bring the purifiers to the proper temperature. The capacity of this apparatus is equivalent to 18,000 to 20,000 100-watt lamps per day.

Synopsis of Recent Chemical & Metallurgical Literature

Industrial Combustion of Gaseous Fuel.—The April, 1921, issue of *Chaleur et Industrie* contains the first part of a paper presented by André Grebel before the Central Office of Rational Combustion. Mr. Grebel suggests three new terms which shall express the main factors involved in the study of combustion.

1. Combustive power (*pouvoir comburivore*) which shall express: the number of volumes of dry air at normal tem-

perature and pressure which are necessary for the complete theoretical combustion of one volume of gaseous fuel.

2. Comburimeter. An apparatus for measuring the comburivorous power.

3. Thermic potential, which shall express the number of calories contained in one cu.m. of the theoretical mixture of combustible gas and air at 0 deg. C. and atmospheric pressure.

The thermic potential P_{th} is given in function of the calorific power of the gas P_{co} and of its comburivorous power P_{co} by the equation

$$P_{th} = \frac{P_{co}}{1 + P_{co}}$$

The value of the thermic potential multiplied by 2.5 gives the theoretical temperature of combustion.

He describes in detail the Grebel-Velter comburimeter. In the accompanying table are summarized the main coefficients of various combustible gases.

Concrete in the Construction of Salt Plants.—An interesting example of the extensive use of concrete at salt plants is given on page 271 of the June issue of *Concrete*. The plant described is that of the Pomeroy Chemical Co., at Pomeroy, Ohio, built in 1919 by the Rust Engineering Co.

The salt beds are about 1,300 ft. below the level of the Ohio River at Pomeroy Bend, the brine, which is a 10 per cent solution with a gravity of 7 deg. Bé., being forced up into the storage tank by an air lift. From there it runs over a measuring weir to a pre-heater, where it is heated to 68 deg. C., and then through tanks in which it is concentrated to a 20 per cent solution.

The brine next passes through concrete mud-settlers and draw settlers and then into concrete grainers, where copper steam pipes concentrate the solution to 35 deg. Bé., when the salt crystallizes and can be removed by a mechanical scraper ready to be packed for shipment. The mother liquor is further concentrated in a concrete bittern grainer and pumped to stills where bromine and calcium chloride are separated.

When the plant is in continuous operation the temperature in the mud settlers is practically constant, varying only 4 or 5 deg. C. The draw settlers are subject to wider variations, since the brine level changes with the filling of the grainers. As the grainers are completely emptied when the salt is removed and are not immediately refilled, their temperature may range from atmospheric (which is sometimes zero) to 82 deg. C., or 176 deg. F.

The settler tanks are 158 ft. long, 11 ft. wide and 3 ft. deep; the grainers have the same length and width, but are only 1 ft. 8 in. deep. Due to their length, these tanks were not built monolithic, but were constructed in sections about 13 ft. long, with bell joints, which allow a smooth inner surface.

When it is remembered that in the bittern grainer the concrete is in contact with concentrated brine of 40 deg. Bé., it is evident that good concrete will withstand even concentrated brine solutions, because the plant has been in operation about two years and there are no appreciable signs of deterioration. The wide temperature range, about 200 deg. F., should also be noted.

Other successful installations are also briefly referred to in this article.

COEFFICIENT OF COMBUSTION OF DIFFERENT GASES

	Acetylene, C_2H_2	Benzene, C_6H_6	Ethylene, C_2H_4	Methane, CH_4	Hydrogen, H_2	Average Illuminating Gas	Carbon Monoxide, CO	Average Pure Water Gas	Average Coke-Oven Gas	Average Blast-Furnace Gas
Weight in g. per cu.m. at 0 deg. C. and atmospheric pressure...	1.102	3.486	1.252	0.715	0.089	0.52	1.251	0.86	1.26	1.30
Highest calorific power per cu. m. in calories...	13,881	36,016	14,906	9,547	3,062	5,000	3,055	2,600	1,100	800
Lowest calorific power per cu.m. in calories...	13,398	34,566	14,000	8,581	2,578	4,600	3,055	2,400	1,060	835
Combustible power, volumes of air...	11.942	35.827	14.334	9.556	2.389	5.0	2.389	2.3	0.9	0.65
Thermic potential, calories...	1,035	938	913	813	760	766	901	727	557	506
Average temperature of flame in bunsen burner, deg. C...	2,400	.....	.....	.....	1,900	1,780	.....	1,775	1,300	.....
Velocity of burning of the theoretical mixture with 2 per cent of oxygen, meters per second...	6.15	.....	.....	0.60	4.50	1.25	2.00	.....	.....	.....
Igniting point in free air, deg. C...	406-440	.....	542-547	650-750	580-590	580-550	644-658	.....	.....	.....

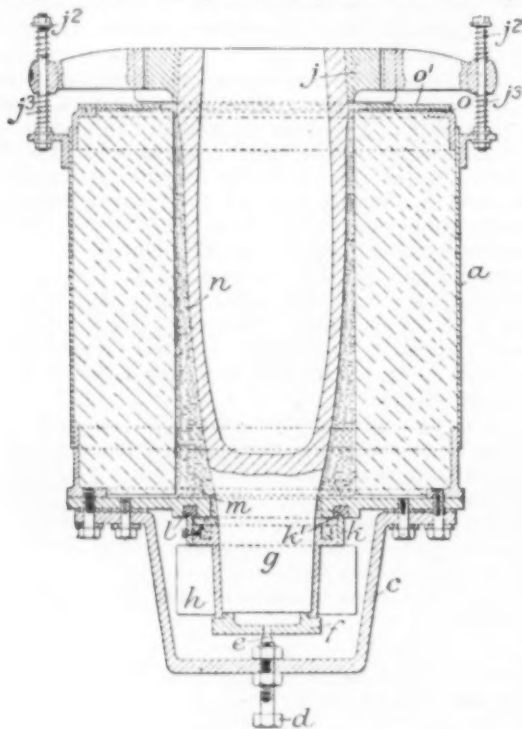
Recent Chemical & Metallurgical Patents

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Process of Extracting Catechin and Catechu-Tannic.—A process for the extraction of catechin and catechu-tannic acid from vegetable substances containing them consists in digesting the disintegrated raw material with hot water in the absence of air and preferably in an autoclave, filtering and concentrating the decoction, then cooling it in absence of air to allow the catechin to separate out, and finally evaporating the filtrate to dryness in absence of air and preferably *in vacuo* to obtain the catechu-tannic acid. The precipitated catechin is purified by washing with cold water and is then dried in the dark either by a current of hot air or by absorption of the contaminating liquid by means of sand contained in bags. As starting material, the wood of *Acacia catechu* or *Acacia sendra* and the leaves and shoots of *Uncaria gambier* are mentioned. (Br. Pat. 161,431; INDIAN WOOD PRODUCTS CO., LTD., Calcutta. June 1, 1921.)

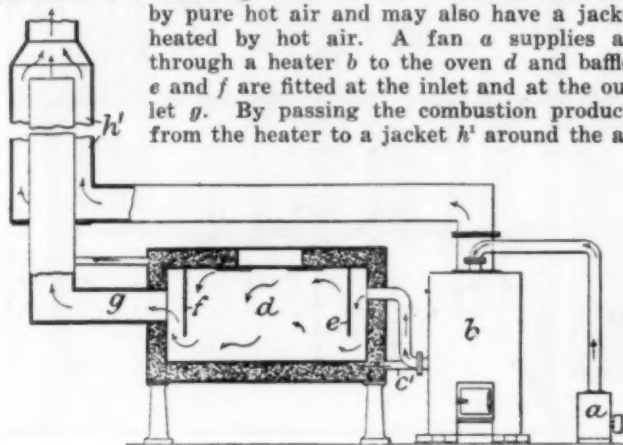
Electric Furnace.—A crucible, tube or the like acting as heating resistance is provided at its upper end with a terminal *j* having one or more arms sliding on guide rods *j*² and partly supported by springs *j*³ to allow expansion. The lower end *g* of the crucible, which is fitted with an air-cooled terminal *h*, may rest on a disk *f* supported through a ball-and-socket or like joint from a bracket *c* secured to the casing *a*. As shown, the disk *f* has a central spherical



recess or hole to receive the rounded or pointed end of an adjusting screw *d* working in the bracket *c*. A ring *k* on the terminal is provided with a sharpened edge *k*¹ bearing on an asbestos or other packing ring *l* in a groove in the casing. In a modification, a tube resistance has a lower water-cooled terminal supported by a ring carried by three adjustable bolts attached to the casing, and a sharp-edged ring in the casing can be screwed down onto an asbestos or other ring on the top of the terminal. In either arrangement, the crucible or tube is surrounded by a filling material within a brick lining of the casing *a*. The filling material may be retained by an asbestos cover plate *o*, held by a flat

metal ring *o*¹. (Br. Pat. 161,603; MORGAN CRUCIBLE CO., LTD., and C. W. SPIERS, Battersea, London. June 1, 1921.)

Vulcanizing Rubber Oven.—An oven particularly applicable for vulcanizing india rubber is heated internally by pure hot air and may also have a jacket heated by hot air. A fan *a* supplies air through a heater *b* to the oven *d* and baffles *e* and *f* are fitted at the inlet and at the outlet *g*. By passing the combustion products from the heater to a jacket *h*¹ around the air



outlet shaft sufficient induced draft is created to dispense with the fan. An independent hot air supply is provided for the jacket by a pipe *c*¹. (Br. Pat. 161,701; F. O. BYNOE, Twickersham, Middlesex. June 8, 1921.)

Continuous Fermentation Process.—A continuous fermentation process for industrial sugar solutions consists in passing the liquid through a series of closed vessels containing filters impregnated with yeast or other ferment, the rate of flow being adjusted so that complete fermentation is effected. The order of the vessels is changed from time to time to prevent destruction of the ferment. The process is applicable to the production of butyl alcohol, glycerine, lactic acid, butyric acid, citric acid, acetone, etc., as well as ethyl alcohol. (Br. Pat. 161,870; A. ROMER, Stuttgart, and DEUTSCH-KOLONIALE GERB. U. FARBSTOFF GES., Karlsruhe. June 8, 1921.)

Lactose.—In manufacturing lactose from whey, the lactalbumen is precipitated by the addition of a substance which produces in the whey a suitable colloid. It is suggested that the precipitation is due to the production of a negatively-electrified colloid in presence of the albumen. Sodium thio-sulphate, yielding colloidal sulphur, is stated to be suitable. The whey may be heated to 70-80 deg. C. before adding the precipitant. (Br. Pat. 161,887; J. TAVROGES, J. W. ROCHE and G. MARTIN, all of Manchester. June 8, 1921.)

Coffee Extracts.—An infusion of roasted coffee is concentrated at or near 0 deg. C. in a high vacuum and the concentrated extract dried either by the circulation of air, or *in vacuo* with the aid of absorbents such as concentrated sulphuric acid or zinc or calcium chloride. The concentration may be effected on the surface of rotary disks or drums dipping into the liquid, heat being supplied by water circulating through the hollow shafts of the disks or drums, and the concentrated liquid removed by scrapers. Small quantities of lactose and dextrine may be added to the dried product. The product may be added to cocoa butter, etc. The extract may be frozen and allowed to evaporate as solid *in vacuo*. (Br. Pat. 161,920; not yet accepted; A. CHALLAS, Neuilly sur Seine, France. June 8, 1921.)

Vegetable Gelatine.—Vegetable gelatine is extracted from seaweed, specially carrageen, by first softening and cleaning the material in hot or cold water, then heating it with water containing a small quantity of an acid, such as acetic acid, a salt or an alkali, in order to break down the vegetable tissue, and after running off the liquor, adding the liquor obtained by subjecting the residue to pressure, and finally filtering the amalgamated liquors and evaporating them to dryness. The seaweed may be bleached before the breaking-down treatment; and a preservative, such as bisulphite or benzoate of soda, may be added before evaporation. The evaporation of the liquid may take place on trays, on heated rollers, or by spraying into a current of hot air. The product is of use as a food. (Br. Pat. 161,612; M. M. MALCOLM and C. S. TOWNSEND, both of London. June 1, 1921.)

Current Events

in the Chemical and Metallurgical Industries

European Interest in Chemical Exposition

That European chemical industries are intensely interested in the forthcoming Chemical Exposition in New York was ascertained by Worth Colwell, who has just returned from Europe. Mr. Colwell is one of the exposition's publicity representatives and with a member of his staff visited England, France and Switzerland. In London, after presenting the various phases of the exposition to Dr. J. P. Longstaff and Sir William Pope of the Society of Chemical Industry, assurances were given that the British chemical experts will be well represented at the American exposition when it opens the week of Sept. 12 in the Eighth Coast Artillery Armory, New York.

In France leading chemists stated that they intend to make the transatlantic trip for the event, and in Switzerland a number of experts are especially interested in the development of chemical machinery in the United States. The future of the dye industry is a topic much discussed abroad and also the fuel problem. The French are particularly interested in the latter, largely because gasoline is costly there and the matter of obtaining substitutes for gasoline or "essence" is of vital importance.

Pennsylvania Industrial Relations Conference

An industrial relations conference, authorized by Gov. William C. Sproul of Pennsylvania, is being arranged by Dr. Clifford B. Connelley, Commissioner of the Department of Labor and Industry, Commonwealth of Pennsylvania, to be held at Harrisburg, Pa., Oct. 24 to 27.

This conference will include the features of the welfare and efficiency conferences and safety congresses of other years. The main topics to be discussed will include industrial waste, industrial co-operation, industrial publicity, industrial education, women and children in industry and the medical supervision of industry.

Prohibition Act Amendment Reported to Senate

The amendments to the national prohibition act which were passed by the House of Representatives June 27 were altered in some minor particulars by the Senate Committee on the Judiciary and were reported to the Senate on July 6. The presumed intent of the bill, as reported to the Senate, is satisfactory to the manufacturers of industrial alcohol, but it is believed that certain modifications will be necessary to make clear what is thought to be the purpose of the committee. As reported to the Senate, the paragraph of particular interest to the manufacturers of industrial alcohol reads as follows:

"If distilled spirits, upon which the internal revenue tax has not been paid, are lost by theft, accidental fire or other casualty while in possession of a common carrier subject to the transportation act of 1920 or the shipping act of 1920, or are lost by theft from a distillery or other bonded warehouse, and it shall be made to appear to the commissioner that such losses did not occur as the result of negligence, connivance, collusion or fraud on the part of the owner or person legally accountable for such distilled spirits, no tax shall be assessed or collected upon the distilled spirits so lost, nor shall any tax penalty be imposed or collected by reason of such loss, but the exemption from the tax and penalty shall only be allowed to the extent that the claimant is not indemnified against or recompensed for such loss. This provision shall apply to any claim for taxes or tax penalties not collected that may have accrued since the passage of the national prohibition act, or that may accrue hereafter."

The Senate committee in the first sentence added the words, "upon which the internal revenue tax has not been

paid." The common carrier was expanded so as to include a carrier by water. The committee in the last sentence added the words, "not collected." It is around this addition that some difference of opinion exists as to the meaning. After the word "warehouse" the bill as passed by the House contains this phrase: "and the person guilty of the theft has been convicted of the offense." That phrase was stricken out by the Senate committee.

Chemical Tonnage on Railroads

Chemicals and explosives furnished railroads of the country 17,336,161 tons of freight during the calendar year of 1920, according to the Interstate Commerce Commission's figures. Fertilizers furnished 13,976,256 tons of freight during the same period. Together these commodities furnished 1.39 per cent of the total tonnage carried by the railroads during the year. During the first quarter of 1921 chemicals and explosives furnished 1,337,246 tons of freight, while fertilizers furnished 2,142,552 tons.

Clay Products Work Begins

With the funds contributed by the associations of brick manufacturers to add to the money appropriated by Congress, the Bureau of Mines now has available approximately \$25,000 for work on heavy clay products. In addition, the Bureau of Standards has an appropriation of several thousand dollars which will be used on those phases of the work which fall within its field.

The first step being taken by the Bureau of Mines is to conduct an investigation as to the practice at a limited number of carefully chosen brick plants which are believed to be typical of many plants of the same character. A part of the work will be done at the University of Illinois. An effort will be made there to determine the maximum rate of vitrification and the maximum rate of water smoking.

Protest Against Duty on Jute

Members of Congress are receiving numerous protests against the duty on jute levied in the tariff bill. Jute fabric takes a duty of 1c. per lb. in the bill recommended by the committee. When the jute fabric is bleached, stenciled, colored or rendered non-flammable, an additional duty of 13 per cent ad valorem is levied. Bags or sacks made from plain woven fabrics of single jute yarns or from twilled or other fabrics composed wholly of jute are dutiable at 1c. per lb. plus 17 per cent ad valorem. Many of the protests are from fertilizer manufacturers who use jute bags for the distribution of their product.

"For the first time in history," says Representative Frear, of Wisconsin, one of the Republican members of the committee, "farmers will now pay for dutiable jute for the bags in which to ship grain. A non-competitive article thus enjoys the distinction of carrying a duty for revenue purposes only in a bill formulated to give protection to American interests, including the farmer."

Data Wanted on Glue and Gelatine

A monograph on "Glue and Gelatine" is being prepared by Jerome Alexander, one of the scientific and technologic monographs being issued under the auspices of the American Chemical Society and the Interallied Congress of Pure and Applied Chemistry. In order to round out his information on the subject, he would be glad to receive memoranda from men engaged in producing glue, gelatine, isinglass, or their substitutes, covering physical properties, chemical behavior, methods of manufacture, testing, and uses or specifications. Dr. Alexander's address for the summer is R.F.D. 4, Ridgefield Conn.

Lead Poisoning in the Pottery Trades

That workers engaged in certain branches of the pottery trade are seriously and constantly exposed to lead poisoning, chiefly from the lead contained in the glaze, and that this danger can be reduced, provided certain facilities and methods are altered by the pottery owners and certain precautions taken by the workers, sums up the findings of a report to the United States Public Health Service made by Consulting Hygienist Bernard J. Newman, Dr. William J. McConnell, Dr. O. M. Spencer and Statistician F. M. Phillips. This report is now in press.

The investigation, which was begun early in 1919, had been requested by the Brotherhood of Operative Potters because they desired to disprove the contentions that their trade was extremely hazardous and that the workmen in certain occupations were likely to develop lead poisoning. These contentions were maintained by life insurance companies as grounds for discrimination in the granting of life insurance policies to certain groups of pottery workers. The investigators received cordial support from both the workers and the pottery managers.

Ninety-two potteries, situated in New Jersey, Ohio, Pennsylvania and West Virginia, employing 21,000 persons, or 53 per cent of the total pottery workers in the United States, were investigated. Only the workers exposed to lead were examined, and of the total examined, 1,504 were males and 398 females.

LEAD RECEIVED THROUGH THE STOMACH

The portal of entrance through which the larger part of the lead is received by the body was found to be the stomach, as the lead was inhaled as dust, retained in the nasal and pharyngeal cavities and later swallowed with mucus, saliva and food. The chewing of tobacco, eating food contaminated with lead dust, and carelessness in personal habits such as wiping the lips, mustache, etc., with glaze-covered fingers, are contributory means toward the entrance of the lead into the human body.

A lesser, but still important portal of entry, is by the lungs, which absorb lead from fumes as well as dust. Absorption of lead through the skin is possible, but was found to be almost negligible in this case.

Risk of lead poisoning differs greatly in the many occupations of the pottery trade. The highest percentage of poisoning among men was found to be among the dip-pers and the next highest among the mixers and the odd-men. The highest percentage of poisoning among the women is among the dipppers' helpers and the ware gatherers. These, among both men and women, are specified occupations, brought into direct contact with the glaze.

The percentage of lead poisoning for these, as well as for other workers, drops as the percentage of lead used in the glaze decreases and lead poisoning of course may be expected to disappear when leadless glaze is used. The adoption and use of leadless glazes is not impossible, for they are used now satisfactorily by European potteries. Certain objections, however, which have prevented their use in America, can at present be overcome only by radical changes in the manufacturing and firing methods. However, great improvements toward the decrease of lead poisoning can be brought about by the adoption of fritted lead glazes, as it would only be necessary to employ two or three men to prepare and frit the glaze against the present methods now employed, whereby large numbers come in contact with the lead glaze, either in its preparation or its use. Methods and formulas for making proper frits are given in the report.

The number of cases of poisoning found in the various occupations of the pottery trade does not alone establish their relative hazard, for this must be considered in the light of numerous modifying factors. The investigation, for instance, showed that the number of cases of lead poisoning increases with age of the workers, with their relative years of exposure and with the length of the work day. It showed also that poisoning is more prevalent among the men than among the women; but this was shown to be due to the fact that the men had been exposed for about three times as many years as the women. It

showed also that poisoning was more prevalent among workers who eat in the workroom or drink from vessels used in the workroom but not properly covered; and in plants where the toilet facilities, ventilation and lighting are bad, and in those where the dust counts and percentage of lead in the dust are high. It is easy to see that any or all of these respective factors are likely to be influenced by the susceptibility of the individual, or play a more or less important part in the production of lead poisoning as the personal habits and tendencies of the individual vary.

The relative weight to be given to these and other minor factors is very difficult to fix definitely, and the authors urge that no one should jump at the conclusion that to remedy any particular condition, other than remove the lead from the glaze, would immediately reduce poisoning.

RECOMMENDATIONS TO PLANT MANAGERS

It is recommended that plant managers should supply: Bubbling fountains with palatable drinking water; adequate dressing rooms with two-compartment lockers for each worker; decent and adequate toilet facilities; and adequate natural and artificial illumination and ventilation. They should discourage eating in the workroom and eating anywhere without previous washing of the hands and face; should encourage the use of overalls; should absolutely forbid dry sweeping and all sweeping of any type during work hours; and should prevent, so far as possible, the spilling of glaze and the consequent dust and dirt.

American Valuation Association

The American Valuation Association was formed by a gathering of representative American manufacturers at the Chemists' Club, in New York City, June 16. Walter Camp, president of the New Haven Clock Co., was chosen president of the association at that time. Other officers are: D. W. Jayne, of The Barrett Co., vice-president; Stanley Williamson, of the Linde Air Products Co., secretary, and F. D. Dodge, of the Toy Manufacturers of the U. S. A., treasurer.

The executive committee includes William Burgess, of the U. S. Potters' Association; Walter Camp; George Chatillon, of John Chatillon & Sons; F. D. Dodge; Clement J. Driscoll, of the Liberty Lace & Netting Works; D. W. Jayne; H. J. Strugnell, of the Remington Arms Co., Stanley Williamson, and J. F. Zoller of the General Electric Co. Mr. Zoller is also chairman of the membership committee, and Mr. Driscoll is chairman of the publicity committee.

It is the purpose of the new association, as announced by the executive committee, to take up every phase of the valuation of imported merchandise and to submit to manufacturers a statement regarding the advantages to be derived by American industry through adopting the American rather than the foreign valuation plan.

Summer Pulp and Paper Course at University of Maine

In order to make full use of its facilities for training technical men for the pulp and paper industry, the University of Maine has instituted a pulp and paper summer school which opened on June 27 with a good-sized class. The courses in pulp and paper chemistry and technology will continue until Aug. 5. They include: Laboratory and small-scale experiments on soda pulp and sulphite pulp, pulp bleaching, paper testing and analysis; general lectures on raw materials of present or probable future use, modern pulp and paper making, costs, use of libraries, visits to mills.

C.W.S. Moves Offices

The headquarters of the Chemical Warfare Service in Washington has been moved from 1800 Virginia Ave. to the seventh wing of the Munitions Building. General Fries' office is No. 1062. Under the new arrangement the entire service is housed compactly in much better offices than those occupied by the service in one of the temporary buildings.

Plans for Fall Meetings of Chemical Societies

Departing from its usual custom, the society of Chemical Industry will hold its annual meeting on this side of the Atlantic. The members will join with the Canadian branch of their organization in sessions in Montreal late in August. Their official hotel quarters will be the Windsor Hotel, while the scientific and business sessions will center at McGill University, where there will be a special convocation. The Canadian and British chemists will then inspect numerous plants and on Thursday, Sept. 1, will visit Grand Mère and Shawinigan Falls industries under the auspices of the Shawinigan Falls section of the society. The delegates will then proceed to Ottawa and Toronto, where they will be entertained by the local sections. On Monday, Sept. 5, they will reach Niagara Falls, where they will view the vast establishments which modern chemistry has created.

On the afternoon of Labor Day the members will cross the border into this country. They will be met by a committee of the American section of their society and conducted through the industrial plants on this side of the Falls. Dinner will be served at Buffalo, after which the visitors and their hosts will leave on a special train east. On their arrival next morning (Sept. 6) at Syracuse they will have luncheon with the Solvay Process Co. and make a tour of the large factory of this corporation. The chemists will then go to Albany and from there take the night boat down the Hudson River to New York City.

The visitors will be welcomed next day by members of the American Section of the Society of Chemical Industry, who will be their hosts at a luncheon. Elaborate arrangements for the reception of the chemists of all three nationalities will be carried out, as now being planned by the various societies, through the co-ordinating committee, of which Dr. B. C. Hesse is chairman and Dr. Allen Rogers is secretary. The festivities, meetings and entertainments which will follow are designed to bring into closer bonds all chemists of Anglo-Saxon stock.

The fall meeting of the American Chemical Society is to be held in New York City Sept. 6 to 10, inclusive. The first contact between the visiting members of the two great organizations which represent chemistry in three lands will be at a lawn party to be given on the afternoon of Sept. 7 to foreign guests and to scientific societies at Columbia University. Other societies asked to participate in the welcoming of the visitors from abroad are: The American Electrochemical Society, the American Institute of Chemical Engineers, the American Section of the Société de Chimie Industrielle and the Manufacturing Chemists Association of the United States. All the foreign guests have also been invited to the smoker and entertainment of the American Chemical Society, which will be held on the evening of Wednesday, Sept. 7.

Scientific sessions of the American Chemical Society are to be held at Columbia University, its official headquarters. To all these meetings the British and Canadian guests have been bidden. They will also be present at the banquet of the American Chemical Society on the evening of Sept. 9 at its hotel headquarters, the Waldorf-Astoria.

An interlude devoted to social activity on Sept. 10, with plenty of golf and tea, and on the 11th to a boat excursion will fill in the time before the next event.

The National Exposition of Chemical Industries, which is to be held during the week of Sept. 12, will constitute a most appropriate sequel to the international gathering of chemists. Here under one roof the visiting chemists will find every type of apparatus used in American chemical plants as well as a wide variety of the products of the chemical industries—all conveniently arranged for study and inspection.

Civil Service Examination

Vacancies for assistant metallurgical chemists at the Naval Ordnance Plant, South Charleston, W. Va., at \$5.44 per day, will be filled from an open competitive examination to be held Aug. 17.

Applicants should apply at once for form 1312 to the Civil Service Commission, Washington, D. C.

Book Reviews

RUBBER MANUFACTURE. By H. E. Simmons, professor of chemistry, University of Akron, Ohio. New York: D. Van Nostrand Co. 150 pp., illustrated. Price \$4.50.

This book deals in a rather general way with the problems of the rubber industry, and apparently has for its object the enlightenment of young compounders who have to deal with the difficulties of so-called "service work." This class of compounders is not as a rule very well grounded in "theory" but is usually well up on the "practice" of keeping the factory going. These compounders will agree to find a substitute for everything used in the factories with the single exception of sulphur. The conception of the type of man this book is intended for is of prime importance.

The writer feels that as a whole the work has been reasonably well done. Here and there are chapters which are exceptionally good, as for example the one on physical testing. From the service man's point of view it is excellent. But all too frequently glaring errors occur, and other evidences of lack of thorough digestion of the matter in question. In addition there are several mistakes which should have been caught by the proofreader. Also terms are used which have not been previously described or otherwise defined. In view of the fact that many of the readers will be young rubber chemists, this is very regrettable. With this in mind the writer will attempt in reviewing the various chapters to correct a few of the errors which appear most glaring.

Chapter I—The History of Caoutchouc, in which the historical features are well covered.

Chapter II—Rubber in the Amazon Basin, in which the South American rubbers are described in sufficient detail for the average compounder. The explanation of the excellence of fine para rubber being due to carbon from the smoke of the *uricuri* palm nut is, to say the least, rather novel.

Chapters III and IV—These describe the rubbers of Africa and Central America respectively. In speaking of the harvesting of guayule the author mentions that the rubber is extracted from the ground shrub by means of naphtha, which is then partly distilled, after which alkali is added. This, he says, holds the resins in solution and the rubber separates out. This is also rather novel.

Chapter V—Rubber plantation practice is described. It is rather good, though not quite exact as to modern methods. It is customary on the best plantations to dilute the latex to constant rubber content and then to add a definite amount of dilute acetic acid.

Chapter VI—A discussion of colloids and colloidal principles is contained in this chapter. The subject matter is aptly chosen and the presentation is particularly good.

Chapter VII—This chapter is an attempt to apply the principles of colloidal chemistry to problems met in coagulation and other phases of the industry. It must be observed that the writer continually confuses lampblack with gas or carbon black. It is the latter and not lampblack which imparts such desirable properties to rubber.

Chapter VIII—This contains a very much condensed review of the work of Eaton, Grantham and others on different means of coagulation and variability. Unfortunately, the subject is somewhat too broad for so much "boiling down." However, the chapter is particularly good and were it not marred by the use of technical terms without explanation and the discussion of subjects such as "Byrne cure" without description it would be excellent.

Chapter IX—This chapter on the theory of the constitution of rubber is good and sufficient for the purpose intended.

Chapter X—This discusses synthetic rubber. The author makes the very apt comment that we might as well attempt to produce synthetic apples. Rubber is a vegetable product and as such can be grown in sufficient quantity to meet the demand.

Chapter XI.—Methods for testing crude rubber are described. It might be observed that most rubber companies have become very careless in this respect. Rubber is bought at the various auctions almost solely on appearance and the reputation of the estate producing it. The wide use of organic accelerators has eliminated the difficulties due to "variability"—i. e., the variation in time of cure when mixed with sulphur alone.

Chapter XII.—The manufacture and use of inorganic fillers are discussed. The subject matter included has not been well chosen or well arranged, and in a few instances is erroneous. For example, the toughening effect of zinc oxide and gas black are not mentioned. One would imagine that the chief use of zinc oxide is as a white pigment, while as a matter of fact about 90 per cent of that consumed contains a little lead and therefore gives the stock a slight yellow cast. Lithopone is a better white pigment than zinc oxide. Red lead passed out of use about five years ago. Many specifications exclude it, and because of its strong oxidizing tendencies most compounders would not use it under any conditions. Under lime the author fails to differentiate between hypothesis and fact in discussing the ability of lime to take up moisture and prevent blowing in stocks. Under barytes, the brown color of "off color" material is due to iron.

Aluminum oxide made through the sodium aluminate route is not "coming into use in some factories," due to the alkali which it contains and which is almost if not completely impossible to extract.

Under the caption of fillers the author has neglected glue, which is now widely employed.

In discussing the production of zinc oxide it will be noted that the author did not avail himself of the services of the New Jersey Zinc Co. Research Laboratories, otherwise he would not have overlooked the decided advantages of this material and his description of the process of manufacture would have been more to the point.

Under antimony, the reviewer ventures to suggest that crimson antimony is usually oxysulphide and not trisulphide. Also "stibnite" is the mineral employed, not "sribnite."

It might also be observed that the manufacturer's explanation of the merits of an antimony tube are highly interesting but not very instructive.

Many of our most satisfactory pigments are lakes.

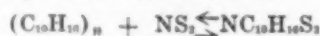
Lampblack is not a toughener and is not extensively used in tire stocks, but gas black is.

Graphite due to its coarse particles has no stiffening effect.

Chapter XIII.—The manufacture and use of organic accelerators are discussed. Of the common accelerators he mentions: aldehyde ammonia, paranitrosodimethylaniline, paraphenylenediamine, hexamethylenetetramine, thiocarbonyl, aniline. He fails to mention: triphenyl guanidine, diphenyl guanidine, formaldehyde aniline, the CS₂ reaction products with dimethylamine and piperidine. Nothing is said regarding the proper proportions of any accelerator. He makes the highly interesting observation that aldehyde ammonia is produced by passing dry ammonia gas into a solution of formalin. This would give hexamethylenetetramine. He should have said "acetaldehyde."

Chapter XIV.—The manufacture and use of rubber substitutes are rather well described. Mineral rubber (MR) deserves more treatment than it received.

Chapter XV.—This chapter contains a description of the theories of vulcanization. Except for poor proofreading it is well done. For example the following reaction is given without explanation of its terms:



The term NS₂ is rather misleading; certainly there is no combination of nitrogen and sulphur like that. The author might have mentioned *n* mols of C₁₀H₁₈ plus *N* mols of S₂, which would certainly have made the passage more clear.

It should be noted that the addition of sulphur to rubber increases with the time of heating, which is contrary to our usual experience with chemical reactions.

Chapter XVI.—This describes "Reclaiming" and is very

good, except for the fact that the Mark's process, which is most generally employed, is not sufficiently emphasized.

Chapter XVII.—The preparation of crude rubber for compounding and manufacturing is recounted.

Chapter XVIII.—The principles of compounding are discussed. From the service man's viewpoint the work is excellent.

Chapter XIX.—Several of the author's methods for analyzing manufactured rubber are described. Chloroform is used rather extensively in place of the carbon bisulphide specified. The Watters and Tuttle method for total sulphur, which is now in almost general use, is not mentioned.

Chapter XX.—This chapter, on Physical Testing, is very good. An illustration of a plastometer is included without mention or description in the text.

Chapter XXI.—The work which Prof. Simmons is undertaking in Akron in the way of establishing a reputable course in rubber chemistry is described. His effort is good and he deserves the support of all American rubber companies and the Rubber Association.

ANDREW H. KING.

Personal

C. L. BACHELDER, who has been assistant in the pulp and paper section of the Forest Products Laboratory, has resigned, and is now with the Consolidated Water Power & Paper Co., Appleton, Wis., under Dr. Otto Kress.

H. H. BARKER, formerly chief chemist and plant manager of the Ore Products Corporation, Denver, Col., is now chief chemist of Corning & Co., Albany, N. Y.

ALFRED T. CHILD, for the past two years associate professor of chemistry at Rose Polytechnic Institute, Terre Haute, Ind., will spend the summer at Stamford, Conn. He plans to visit industrial plants.

VANCE P. EDWARDES, who has been with the Forest Products Laboratory for the past three years, is now with the Interlake Pulp & Paper Co., Appleton, Wis., in the sulphite department.

REIMAN G. ERWIN, formerly with the Roessler & Hasslacher Chemical Co., St. Albans, W. Va., is now chemical engineer with the Celluloid Co., Newark, N. J.

CHARLES H. MACDOWELL, president of the Armour Fertilizer Works, was re-elected president of the National Fertilizer Association at the recent annual convention held at White Sulphur Springs, W. Va. This is Mr. MacDowell's fourth term as president of the association, he having been previously elected to that office in 1903 and 1904 and again in 1920.

JOHN J. MULLIGAN, who was formerly plant metallurgist for the U. S. S. Lead Refinery, Inc., East Chicago, Ind., is now assistant superintendent for the same company.

DR. HENRY P. TALBOT has been appointed acting dean of Massachusetts Institute of Technology to succeed Dr. A. E. Burton, who recently resigned. Dr. Talbot is chairman of the faculty, and will also retain the directorship of the department of chemistry.

ARTHUR L. WALKER, professor of metallurgy at the Columbia School of Mines, has gone to Europe for the vacation months.

The Society for the Promotion of Engineering Education has elected the following officers for the ensuing year: President, Charles F. Scott, Yale University; vice-presidents, H. J. Hughes, Harvard University, and E. J. McCaustland, University of Missouri; secretary, F. L. Bishop, University of Pittsburgh; treasurer, W. O. Wiley, New York City. The following are members of the Council: P. H. Daggett, University of North Carolina; J. H. Dunlap, University of Iowa; M. L. Enger, University of Illinois; J. C. L. Fish, Leland Stanford University; F. E. Gieseke, University of Texas; Morris Knowles, Pittsburgh, Pa., and O. M. Leland, University of Minnesota.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, July 11, 1921.

Trading of a desultory character has featured the chemical market during the past week and there has been little in the way of price changes uncovered. A fair amount of miscellaneous inquiries was received, but these did not result in any large lot transactions and most of the business placed has been in small lots representing the actual wants of the consuming trade. The holiday exerted its usual quieting influence and the close of the week found business dormant in most local directions.

The first draft of the new tariff bill is now under discussion and the trade can draw its own conclusions from what Mr. Fordney thinks about the import duty as a protection to the American chemical industry. Importations of German chemicals are increasing and may be expected to increase until the new tariff bill becomes a law, the time being purely problematical. Meanwhile some relatively low prices are being named on chemicals which forecast dullness for American goods.

Among chemicals which have shown some activity are soda ash, caustic soda, bichromate, prussiate and nitrite of soda. The first two have shown considerable steadiness. Bleaching powder has sold more freely and the outlook has improved for business in this chemical through the recent settlement of the labor strike at paper mills in this country and Canada. Bleach showed a better tone at the close with some sellers a little higher in their views. Among the smaller items citric acid has ruled about steady. Imported tartaric acid has not declined any further regardless of a lowering in the price of domestic producers. Formaldehyde showed some irregularity in second hands. Camphor has been in fair request at steady prices all around. In general, it can be stated that quite a few can see no prospects of material improvement in trade conditions during July and August, but early in September it is expected that the beginning of a general recovery will become pronounced. For more than six months manufacturers and others have been engaged in working off high-cost inventories. This has been largely at the expense of earnings. It has added to the feeling of depression that has prevailed and probably in many instances has made the situation appear to be much worse than it is in reality. Consumers are uncertain as to future prices and having been taught a severe lesson because of overexpansion in the inflation period, are now exceedingly careful and will not take the chance of laying in supplies at what might be considered high prices later on. The country has gone from one extreme to another and that there will be a rebound is an inevitable conclusion.

GENERAL CHEMICALS

Spot *caustic soda* is being held steady at \$4.10 per 100 lb. for standard brands, and moderate trading was reported at this price. It is stated that miscellaneous inquiries are reaching the market in fair volume and that business in the aggregate is quite satisfactory. Resale offerings are not heavy and some sellers showed a disposition to advance their views. Producers are maintaining the contract price of 34c. per lb., basis 60 per cent, f.o.b. works.

Producers report a quiet trading in *fluoride of soda* and state that small sales are going through on the basis of 12c. per lb. Buyers seem to be fairly well supplied with this material and are content to operate in small quantities. Prices on spot *nitrite of soda* are heard all the way from 7½@8c. per lb., depending entirely upon the seller. Scattered transactions were reported at 7½c. per lb. As stated previously, stocks of this chemical appear to be well held in most directions and there continues to be a

feeling that the market would respond to any buying movement. Spot *bichromate of potash* is generally quoted at 11½@12c. per lb., but odd lot sales have been made below this price and in one direction it was stated that 11c. could be done. Activity has continued along narrow lines and the desire to secure new business in the face of a quiet demand has kept the market somewhat irregular.

Dealers in *caustic potash* quote the 88-92 per cent at 5@5½c. per lb., and in some quarters it was intimated that the inside price might be shaded on a firm offer. Rumors were heard that a few small lots have changed hands down to 4½c. per lb., but this figure did not represent the actual market, according to sellers. Standard *bichromate of soda* was quoted at 8½@8¾c. per lb. Scattered transactions were noted at 8½c. but the market appeared quiet in most directions, with offerings relatively small among second hands. Imported *prussiate of soda* was quoted at 12½@12¾c. per lb., according to seller. Odd lots might have been purchased at slight concessions, but the market in general looked somewhat steadier than it did at the close of the previous week. Resale *soda ash* in single bags sold at \$2.10 per 100 lb. and upward, according to quantity. Barrels were in fair request, with small lot sales noted up to \$2.60 per 100 lb., while 2½c. per lb. was named in some quarters for carlots. No change in prices was heard at the works, and sellers named \$1.60 per 100 lb. for single bags basis 48 per cent. Prices are a shade easier on formaldehyde with prominent sellers offering as low as 13½c. per lb. for immediate shipment. Odd lot sales have been made by dealers down to 13c. and the extreme range is 13@14c. per lb., depending upon seller, brand and quantity. Trading in *oxalic acid* is taking at 17½@18c. per lb. on spot. Some sellers are asking above 18c. for domestic material and this variety is governed entirely by the views of the individual seller at present. The minimum price quoted is for imported stock.

COAL-TAR PRODUCTS

Trading in the coal-tar products market during the past week has shown no particular change from that of previous reports, which were of a somewhat improved tone with inquiries coming from a broader field and concerning a larger variety of products. The amounts involved in transactions were confined to small quantities for use at the moment and nothing in the nature of contract business was developed. There was not much activity in the crude market outside of *benzene*. The demand for both the pure and the 90 per cent is steady and prices are firm. Supplies of *naphthalene* are plentiful and with the lack of demand prices depend upon the seller, with some quoting as low as 7c. per lb. and others steady in their views at 8½c. per lb. for flakes. The tone in the market for *phenol* is improving and some sellers report a more active tendency among buyers. There is very little business being done below 10c. per lb., while the range was up to 15c. per lb., depending on quantity. Intermediates were steady in tone and small lots continued to move in a routine manner. A fair demand was reported for *phthalic anhydride* and prices were steady at 45@50c. per lb. *Aniline oil* was dull and prices remained practically unchanged. *Beta naphthol* was somewhat lower at 35@38c. per lb., with trading reported quiet. Consumers of *aniline oil* are interested only in supplies sufficient for the moment and so far this week no large sales were reported. Prices, however, remained steady at 20@26c. per lb., depending upon quantity and seller.

There was very little activity noticeable in any quarter of the market on *dimethylaniline*. Prices varied somewhat depending on seller with a range from 40@50c. per lb. The tendency of the demand for *beta naphthol* has seemed to fall off and while factors in some quarters are fairly steady in their quotations, sellers in some quarters will shade on a firm order so that 35c. per lb. has been possible. Factors state there is very little change taking place in the situation on *alpha-naphthylamine* and very little interest is shown on the part of consumers. Prices are held on the recently quoted basis of 35@40c. per lb. The market on *paranitraniline* shows few signs of any

broadening and only a moderate routine business is passing, while prices depend on seller, with 85c. per lb. heard in some quarters. A firm order for round lots might bring shading. Factors continue to report a fairly steady consuming demand for moderate quantities of *para phenylenediamine*. The market is in a fair condition on supplies, with prices ranging from \$1.75@2 per lb., depending on quantity.

MISCELLANEOUS MATERIALS

Interest in the market for miscellaneous materials centered in the publication of details on the Fordney tariff bill. The bill as presented to the House of Representatives provides for higher duties on *barytes* and *zinc oxide*. The measure provides for a duty of \$4 per ton on crude *barytes* and \$7.50 per ton on the manufactured. The market held at \$36@42 per ton on prime material and \$26@28 per ton on off colored. Prices on *blanc fixe* ruled steady, but closed unchanged at 44c. per lb. in carlots and 44c. per lb. for less than carlots. There was a fair inquiry noted for this material. Interest in *zinc oxide* centered around the announcement made by leading producers of a general reduction in prices. The decline amounts to 14c. per lb. on the lead-free and French process *zincs*. Lead-free closed at 74c. per lb. carlots, with the 5 per cent at 74c. and the 10@35 per cent at 7c. per lb. French process, red seal, closed at 84c., carlot basis, with the green seal at 94c. per lb. and the white seal at 11c. The XX variety was quoted at 74c. per lb.

VEGETABLE OILS

Spot prices for *chinawood oil*, so far as importers were concerned, held around 15c. per lb., but resale material was available here and there at concessions. Futures were neglected, but held nominally at 104@104c. per lb., hardwood barrels included, c.i.f. N. Y. The feature of the market on *coconut oil* was the sale of several large parcels of copra at comparatively steady prices. One lot of 900 tons of Java copra sold at \$4.95 per 100 lb., July shipment. Another lot sold at 5c. per lb. c.i.f. N. Y. The domestic oil trade was not very active with prices more or less nominal. There were sellers of domestic Ceylon type oil at 84c. per lb., sellers' tanks, N. Y. On the coast 84c. was bid for snowflake oil, immediate shipment, but no sales were recorded. Outside lots of Manila oil for immediate shipment were offered at 84c. lb. bulk basis, c.i.f. N. Y. with intimations that that figure might be shaded on a firm bid. *Cochin style oil* held at 11@114c. per lb. on spot. Owing to the strength in cottonseed oil and other competing oils sellers in the West were not free in offering crude *corn oil* and in some directions 6c. per lb. was regarded as an inside figure, tank car basis, f.o.b. Chicago. There was a good inquiry for domestic crude *peanut oil*, and sales were noted in the past few days at prices ranging from 61@64c. per lb., tank cars, f.o.b. mills, southeast. The sale at the outside figure was noted during the week. The market was firm reflecting the uplift in crude cottonseed, which actually sold at 64c. per lb. f.o.b. Texas.

The St. Louis Market

St. LOUIS, Mo., July 8, 1921.

Business in the general list of drugs and fine chemicals continues to increase, with large and frequent inquiries and in most cases, resulting in business. The demand for heavy chemicals has been considerably lighter in the past two weeks, as the market for the most part remains unchanged. The prediction of two weeks ago has apparently been justified—i.e., that the second-hand stocks are about depleted and that the buyer can again safely take the manufacturer's schedule as indicative of the real market price. The market in the past on many chemicals was weakened owing to the severe foreign competition, but since the introduction of the proposed tariff bill made public during the last week, the market is again assuming a firm position and many commodities are stiffening.

ALKALIS

Caustic soda demand has been very poor, with manufacturer's schedule prevailing. The demand for *soda ash* is very light, with the price in round lots holding at \$2.95@

\$3.25 per 100 lb., basis 58 per cent light. *Bicarbonate of soda* and *sal soda* have a demand much under routine, with prices remaining the same.

INDUSTRIAL CHEMICALS

Carbon bisulphide is one of the very active items at the present moment, with many inquiries resulting in business. The demand for *hyposulphite of soda* continues to be steady and is moving through regular channels. Sulphur remains at \$2 per 100 lb. for the commercial, with demand a trifle light within the previous two weeks. A few sales have been reported below cost in an effort to move heavy stocks of this item.

DRUGS AND PHARMACEUTICALS

Acetanilide continues to be quiet. *Acetphenetidine* is not moving as rapidly as might be expected, inquiries being small and few. The *bromide* situation has undergone no material change. Foreign importations continue to be noted and supplies are liberal. *Caffeine* is in fair demand with no change in price. *Carbon tetrachloride* has been in a fair demand, with a price at 12c. per lb. in 100-gal. drums. The status of *chloral hydrate* has had no change, with a normal demand from regular sources. *Cream of tartar* continued to maintain its present schedule with a limited demand. There is a decided improvement in the demand for *glycerophosphates* and a very substantial amount of business is passing. *Hydrogen peroxide* continues to move very briskly. Some of the *hypophosphite salts* are showing an increase. *Iodides* have shown a fair increase and manufacturers hope this condition will continue with the present price reduction brought about by the keen competition of second hands. *Mercurials* have shown no improvement since last report. *Phenolphthalein* continues to move in a routine way with a slight improvement in inquiries. *Rochelle salt* and *seidlitz mixture* are lacking interest since the recent reduction in price. The second-hand lots of *saccharine* are still a disturbing factor to the market and until these goods are disposed of factors do not look for any improvement. A routine business of *salicylates* is being enjoyed. *Sodium benzoate* remains easy and the demand is rather light. Competition in this commodity does not seem to be as sharp as it was recently. The hot weather which has been experienced lately has had a good effect on *zinc stearate*, which is now moving in large volume and jobbers should carry liberal stocks. *Glycerine* again declined to 154c. per lb. spot, with contracts offered at 16c. Most of the six months' contracts were signed at the latter figure.

ACIDS

The position of heavy acids has not made any material change. However, a fair improvement has been noted with no change in price. Factors are still disappointed in the *citric acid* situation. The demand is a trifle better, but soft drink manufacturers are still averse to anticipating and purchasing larger quantities. The movement into consuming channels is also below normal. The activity in *pyrogalllic acid*, both *resublimed* and *crystals*, remains since last report and some very nice business is being transacted. Some very large inquiries have been received for *succinic acid*, and in most cases business has resulted. Since the reduction in price recently announced by manufacturers, there has been nothing of importance developed in the *tar-taric acid* situation.

VEGETABLE OILS

Linseed oil has declined slowly the past two weeks and now holds at 75c. per gal. in cooerage, with little contracting. *Castor oil* still holds at 104c., with only a fair demand. *Turpentine* has likewise been affected by the slow-up of the paint industry and is offered at 57c. per gal. in 5-bbl. lots.

PAINT MATERIALS

The paint industry is experiencing the dullest season in years, and as a consequence the demand for *barytes* and *lithopone* has been exceedingly light. Though prices remain the same, shading is to be expected when there is any amount of business in sight.

The Iron and Steel Market

PITTSBURGH, July 8, 1921.

Last week it was common talk in the steel trade that formal price reductions would be announced this week, probably on Tuesday. On Monday night the Bethlehem Steel Co. gave to the Associated Press a statement that it was reducing its regular prices by certain amounts. Other independents promptly "recognized" the new prices and on Wednesday night the United States Steel Corporation made an announcement that it had reduced its prices correspondingly.

At the middle of April a uniform market was developed, by the independents making some advances from their former cut prices while the Steel Corporation reduced its prices. Since then there had been a plain decline of \$5 a net ton in wire products and in sheets. In other products the April prices were nominally though in most cases not actually the market.

The prices thus announced are: Billets, \$33; slabs, \$34; sheet bars and small billets, \$35; bars, 1.90c.; shapes and plates, 2c.; blue annealed sheets, 2.65c.; black sheets, 3.50c.; galvanized sheets, 4.50c. Tin plate is \$5.75 per base box. It had been \$6.25 by the April schedule, while there had been shading to \$5.75 or less on stock plate but little shading on plates ordered for production.

The new prices are the market on sheets, and probably the market on bars. On plates prices of 1.90c. and less had already been named quite freely and it is quite improbable that the market will advance to a 2c. level.

New prices for pipe, hoops and some other commodities are still to be announced. The April price on hoops had been 2.75c., but 2.50c. has frequently been done in the past two or three weeks.

The season cotton tie price has been announced, \$1.35 per bundle, weighing 45 lb. This compares with \$2 in 1920, \$1.70 in 1919, \$2.10 in 1918 and 1917 and an average of 79½c. in the ten years 1904 to 1913 inclusive.

TRADE AWAITING "FINAL" REDUCTION

For months past the trade has been looking forward to the time, indefinitely in the future, when the steel market would experience a sort of "final" decline—i. e., a decline that would occur when buyers became ready to take hold in something like a free way and there would be an incentive to the mills to make prices that would induce the placing of business. The declines to date have not been of that character, since they have not perceptibly increased the volume of business, and they have occurred simply through mills competing with one another for the limited quantity of business that was going to be placed anyhow. There is no sign yet of the time when a buying movement can be started. Consumers are still engaged in liquidating stocks of steel and of their products made from steel, and they do not seem to be making very rapid progress.

The condition, of course, is that the production and shipments of steel by the mills is well below the rate of actual consumption, or wearing out, or putting into employment, of steel. The movement in steel is far below a relation to the volume of business activity generally, even though general business is relatively quiet. It is rather startling to observe that debits to individual accounts at banks as reported by the Federal Reserve Board and which the board says "are indicators of the volume of the nation's business" were only 19 per cent less in the five weeks ended May 25 than in the same period of 1920, whereas the production of steel is barely 25 per cent of the rate of a year ago.

PRODUCTION OF STEEL AND PIG IRON

Production of steel ingots is now at about 10,000,000 gross tons a year, or at a shade under 20 per cent of capacity, the Steel Corporation operating at above that rate and the independents at below it, some independent mills being entirely closed. Pig-iron production is at the rate of about 11,000,000 tons.

Pig iron prices continue to soften, prices being off 50c. in the week, with bessemer at \$22, basic at \$20 and foundry at \$21, valley furnaces. Connellsville coke is a shade stronger, being rather firm at \$3.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12	\$0.12
Acetone.....lb.	2.50	2.75
Acid, acetic, 28 per cent.....100 lbs.	4.00	4.25
Acetic, 56 per cent.....100 lbs.	9.75	10.00
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	13½	14
Boric, crystals.....lb.	15	15½
Boric, powder.....lb.	13½	14
Citric.....lb.	1.30	1.65
Hydrochloric.....100 lb.	12½	12½
Hydrofluoric, 52 per cent.....lb.	10	11
Lactic, 44 per cent tech.....lb.	4.04	05½
Lactic, 22 per cent tech.....lb.	4.00	4.50
Molybdic, C. P.....lb.	06½	06½
Muriatic, 20 deg. (see hydrochloric).....lb.	07	07½
Nitric, 40 deg.....lb.	17½	18
Nitric, 42 deg.....lb.	13½	14
Oxalic, crystals.....lb.	20	25
Phosphoric, 50 per cent solution.....lb.	1.90	2.15
Picric.....lb.	11.75	14.00
Pyrogallol, resublimed.....lb.	13.00	15.00
Sulphuric, 60 deg., tank cars.....ton	18.00	20.00
Sulphuric, 60 deg., drums.....ton	21.00	22.00
Sulphuric, 66 deg., tank cars.....ton	21.00	22.00
Sulphuric, 66 deg., drums.....ton	21.00	22.00
Sulphuric, 66 deg., carboys.....ton	21.00	22.00
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00	23.50
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	31.00	32.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	33.00	34.00
Tannic, U. S. P.....lb.	90	1.00
Tannic (tech.).....lb.	50	55
Tartaric, crystals.....lb.	29	30
Tungstic, per lb. of W.O.....lb.	1.30	1.40
Alcohol, Ethyl.....gal.	4.85	5.00
Alcohol, Methyl (see methanol).....gal.	31	36
Alcohol, denatur ed, 188 proof.....gal.	38	42
Alcohol, denatur ed, 190 proof.....gal.	03½	04
Alum, ammonia lump.....lb.	03½	04
Alum, potash lump.....lb.	10	11
Alum, chrome lump.....lb.	01½	02
Aluminum sulphate, commercial.....lb.	02½	03
Aluminum sulphate, iron free.....lb.	07	07½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	30	32
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	08	08½
Ammonium carbonate, powder.....lb.	06½	06½
Ammonium chloride, granular (white sal ammoniac).....lb.	07½	08
Ammonium chloride, granular (gray sal ammoniac).....lb.	07	07½
Ammonium nitrate.....lb.	2.60	2.75
Ammonium sulphate.....100 lb.	4.00	4.25
Amylacetate.....gal.	2.50	3.00
Amylacetate tech.....gal.	07½	08
Arsenic oxide, (white arsenic) powdered lb.....lb.	11	11½
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	59.00	59.50
Barium chloride.....ton	20	21
Barium dioxide (peroxide).....lb.	07½	07½
Barium nitrate.....lb.	04½	05
Barium sulphate (precip.) (blanc fixe).....lb.	05½	06
Bleaching powder (see calc. hypochlorite).....lb.	08	09
Blue vitriol (see copper sulphate).....lb.	08	09
Borax (see sodium borate).....lb.	08	09
Bromine (see sulphur, roll).....lb.	41	42
Bromine.....lb.	2.00	2.05
Calcium acetate.....100 lbs.	04½	04½
Calcium carbide.....lb.	23.50	24.00
Calcium chloride, fused, lump.....ton	01½	02
Calcium chloride, granulated.....lb.	2.15	2.25
Calcium hypochlorite (bleach powder) 100lb.....lb.	1.40	1.50
Calcium peroxide.....lb.	15	16
Calcium phosphate, tribasic.....lb.	75	78
Camphor.....lb.	06½	07
Carbon bisulphide.....lb.	10½	10½
Carbon tetrachloride, drums.....lb.	06	07
Carbonyl chloride (phosgene).....lb.	11	12
Caustic potash (see potassium hydroxide).....lb.	60	75
Caustic soda (see sodium hydroxide).....lb.	08	09
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	08	09
Chloroform.....lb.	3.00	3.10
Cobalt oxide.....lb.	19	19½
Copperas (see iron sulphate).....lb.	20	21
Copper carbonate, green precipitate.....lb.	50	62
Copper cyanide.....lb.	05½	06
Copper sulphate, crystals.....lb.	05½	06
Cream of tartar (see potassium bitartrate).....lb.	08	09
Epsom salt (see magnesium sulphate).....lb.	08	09
Ethyl Acetate Com. 85%.....gal.	85	1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	50	52
Formaldehyde, 40 per cent.....lb.	13	14
Fusel oil, ref.....gal.	3.00	3.25
Fusel oil, crude.....gal.	1.75	2.00
Glauber's salt (see sodium sulphate).....lb.	16	16½
Glycerine, C. P. drums extra.....lb.	3.65	3.75
Iodine, resublimed.....lb.	10	20
Iron oxide, red.....lb.	19.00	20.00
Iron sulphate (copperas).....ton	11½	13
Lead acetate.....lb.	09	09½
Lead arsenate, paste.....lb.	15	20
Lead nitrate.....lb.	08½	09
Litharge.....lb.	1.30	1.40
Lithium carbonate.....lb.	10	11
Magnesium carbonate, technical.....lb.	09	09½
Magnesium sulphate, U. S. P.....100 lb.	2.40	2.75
Magnesium sulphate, technical.....100 lb.	1.20	1.75
Methanol, 95%.....gal.	77	80
Methanol, 97%.....gal.	80	85
Nickel salt, double.....lb.	14	14½
Nickel salt, single.....lb.	15	15½
Phosgene (see carbonyl chloride).....lb.	45	46
Phosphorus, red.....lb.	47	50
Phosphorus, yellow.....lb.	35	37
Potassium bichromate.....lb.	11½	12

		Cariots	Less Cariots
Potassium bitartrate (cream of tartar).....	lb.	\$.30 — .31	\$0.30 — \$0.31
Potassium bromide, granular.....	lb.	.16 — .25	.16 — .25
Potassium carbonate, U. S. P.....	lb.	.35 — .40	.45 — .50
Potassium carbonate, 80-85%.....	lb.	.05 — .051	.06 — .07
Potassium chlorate, crystals.....	lb.	.071 — .07	.08 — .12
Potassium cyanide.....	lb.	.26 — .28	.26 — .28
Potassium hydroxide (caustic potash).....	lb.	.05 — .051	.051 — .06
Potassium muriate, 80% K.C.L.....	ton	45.00 — 50.00	
Potassium iodide.....	lb.		2.75 — 3.00
Potassium nitrate.....	lb.	.091 — .09	.10 — .12
Potassium permanganate.....	lb.	.29 — .30	.31 — .32
Potassium prussiate, red.....	lb.	.35 — .37	.38 — .40
Potassium prussiate, yellow.....	lb.	.24 — .241	.25 — .251
Potassium sulphate (powdered).....	per unit		1.50 — 1.75
Rochelle salts (see sodium potas tartrate).....			
Salammoniac (see ammonium chloride).....			
Salt soda (see sodium carbonate).....			
Salt cake.....	ton		26.00 — 28.00
Silver cyanide.....	oz.		1.35 — 1.38
Silver nitrate.....	oz.		.40 — .41
Soda ash, light.....	100 lb.	2.10 — 2.15	2.20 — 2.50
Soda ash, dense.....	100 lb.	2.40 — 2.45	2.50 — 2.75
Sodium acetate.....	lb.	.041 — .04	.041 — .051
Sodium bicarbonate.....	100 lb.	2.25 — 2.40	2.50 — 2.75
Sodium bichromate.....	lb.	.081 — .08	.08 — .091
Sodium bisulphate (nitre cake).....	ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphate powdered, U. S. P.....	lb.	.05 — .051	.051 — .06
Sodium borate (borax).....	lb.	.06 — .061	.061 — .07
Sodium carbonate (soda).....	100 lb.	1.90 — 2.00	2.10 — 2.40
Sodium chlorate.....	lb.	.071 — .07	.08 — .081
Sodium cyanide.....	lb.	.19 — .21	.22 — .30
Sodium fluoride.....	lb.	.11 — .12	.12 — .13
Sodium hydroxide (caustic soda).....	100 lb.	4.10 — 4.20	4.25 — 4.65
Sodium hyposulphite.....	lb.		.031 — .03
Sodium nitrate.....	100 lb.	2.90 — .	3.00 — .
Sodium nitrite.....	lb.	.071 — .07	.07 — .08
Sodium peroxide, powdered.....	lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic.....	lb.	.041 — .04	.05 — .051
Sodium potassium tartrate (Rochelle salts).....	lb.		.26 — .27
Sodium prussiate, yellow.....	lb.	.121 — .12	.13 — .131
Sodium silicate, solution (40 deg.).....	lb.	1.00 — 1.15	1.25 — 1.40
Sodium silicate, solution (60 deg.).....	lb.	.021 — .03	.031 — .03
Sodium sulphate crystals (Glauber's salt) 100 lbs.....	100 lbs.	1.50 — 1.75	2.00 — 2.25
Sodium sulphide, fused, 60-62 per cent (conc.).....	lb.	.051 — .05	.06 — .061
Sodium sulphite, crystals.....	lb.	.031 — .04	.041 — .04
Strontium nitrate, powdered.....	lb.	.15 — .151	.16 — .17
Sulphur chl ride, red.....	lb.	.07 — .071	.071 — .08
Sulphur, crude.....	ton	20.00 — 22.00	
Sulphur dioxide, liquid, cylinders extra.....	lb.	.08 — .081	.09 — .10
Sulphur (sublimed), flour.....	100 lb.		2.25 — 3.10
Sulphur, roll (brimstone).....	100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent.....	lb.	.18 — .19	
Tin oxide.....	lb.		.40 — .42
Zinc carbonate, precipitate.....	lb.	.151 — .16	.161 — .17
Zinc chloride, gran.....	lb.	.11 — .111	.111 — .12
Zinc cyanide.....	lb.	.45 — .49	.50 — .60
Zinc dust.....	lb.	.111 — .11	.111 — .121
Zinc oxide, XX.....	lb.	.071 — .07	.08 — .09
Zinc sulphate.....	100 lb.	3.00 — 3.25	3.30 — 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb.	\$1.10 — \$1.15
Alpha-naphthol, refined.....	lb.	1.25 — 1.30
Alpha-naphthylamine.....	lb.	.35 — .40
Aniline oil, drums extra.....	lb.	.20 — .27
Aniline salts.....	lb.	.26 — .29
Anthracene, 80% in drums (100 lb.).....	lb.	.75 — 1.00
Benzaldehyde U. S. P.....	lb.	1.50 — .
Benzidine, base.....	lb.	.85 — 1.00
Benzidine sulphate.....	lb.	.75 — .85
Benzoic acid, U. S. P.....	lb.	.60 — .65
Benzoate of soda, U. S. P.....	lb.	.55 — .60
Benzene, pure, water-white, in drums (100 gal.).....	gal.	.27 — .32
Benzene, 90% in drums (100 gal.).....	gal.	.25 — .28
Benzyl chloride, 95-97%, refined.....	lb.	.28 — .30
Benzyl chloride, tech.....	lb.	.20 — .25
Beta-naphthol benzoate.....	lb.	3.50 — 4.00
Beta-naphthol, sublimed.....	lb.	.70 — .75
Beta-naphthol, tech.....	lb.	.35 — .38
Beta-naphthylamine, sublimed.....	lb.	1.75 — 1.80
Cresol, U. S. P., in drums (100 lb.).....	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.).....	lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums.....	gal.	.70 — .80
Cresylic acid, 75-97%, dark, in drums.....	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums.....	gal.	.45 — .50
Dichlorobenzene.....	lb.	.06 — .09
Diethylaniline.....	lb.	1.20 — 1.25
Dimethylaniline.....	lb.	.40 — .50
Dinitrobenzene.....	lb.	.26 — .28
Dinitrochlorobenzene.....	lb.	.20 — .30
Dinitronaphthalene.....	lb.	.30 — .40
Dinitrophenol.....	lb.	.35 — .40
Dinitrotoluene.....	lb.	.27 — .30
Dip oil, 25% car lots, in drums.....	gal.	.40 — .45
Diphenylamine.....	lb.	.60 — .65
H-acid.....	lb.	1.20 — 1.30
Meta-phenylenediamine.....	lb.	1.15 — 1.20
Monochlorobenzene.....	lb.	.12 — .14
Monocethylaniline.....	lb.	1.75 — 1.85
Naphthalene crushed, in bbls.....	lb.	.07 — .08
Naphthalene, flake.....	lb.	.07 — .08
Naphthalene, balls.....	lb.	.081 — .09
Naphthionic acid, crude.....	lb.	.70 — .75
Nitrobenzene.....	lb.	.12 — .15
Nitro-naphthalene.....	lb.	.30 — .35
Nitro-toluene.....	lb.	.16 — .18
Ortho-amidophenol.....	lb.	3.10 — 3.20
Ortho-dichlorobenzene.....	lb.	.15 — .20
Ortho-nitro-phenol.....	lb.	.80 — .85
Ortho-nitro-toluene.....	lb.	.15 — .20
Ortho-toluidine.....	lb.	.20 — .25
Para-amidophenol, base.....	lb.	1.50 — 1.60
Para-amidophenol, HCl.....	lb.	1.75 — 1.80

Para-dichlorobenzene.....	lb.	.15 — .20
Paranitroaniline.....	lb.	.85 — 1.00
Para-nitrotoluene.....	lb.	.85 — .95
Para-phenylenediamine.....	lb.	1.75 — 2.00
Para-toluidine.....	lb.	1.25 — 1.40
Phthalic anhydride.....	lb.	.50 — .60
Phenol, U. S. P., drums.....	lb.	.11 — .13
Pyridine.....	gal.	2.00 — 3.50
Resorcinol, technical.....	lb.	1.75 — 1.85
Resorcinol, pure.....	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls.....	lb.	.19 — .22
Salicylic acid, U. S. P.....	lb.	.20 — .25
Salol.....	lb.	.80 — .85
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.14 — .16
Sulphanilic acid, crude.....	lb.	.30 — .35
Tolidine.....	lb.	1.25 — 1.35
Toluidine, mixed.....	lb.	.40 — .45
Toluene, in tank cars.....	gal.	.25 — .28
Toluene, in drums.....	gal.	.28 — .31
Xylenes, drums, 100 gal.....	lb.	.40 — .45
Xylene, pure, in drums.....	gal.	.40 — .45
Xylene, pure, in tank cars.....	gal.	.45 — .
Xylene, commercial, in drums, 100 gal.....	gal.	.33 — .35
Xylene, commercial, in tank cars.....	gal.	.30 — .

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....	lb.	\$0.24 — \$0.25
Beeswax, refined, light.....	lb.	.27 — .28
Beeswax, white pure.....	lb.	.42 — .45
Carnauba, Florida.....	lb.	.58 — .60
Carnauba, No. 2, North Country.....	lb.	.25 — .26
Carnauba, No. 3, North Country.....	lb.	.15 — .16
Japan.....	lb.	.17 — .171
Montan, crude.....	lb.	.061 — .062
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.03 — .031
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.021 — .
Paraffine waxes, refined, 118-120 m.p.....	lb.	.03 — .031
Paraffine waxes, refined, 125 m.p.....	lb.	.031 — .04
Paraffine waxes, refined, 128-130 m.p.....	lb.	.041 — .041
Paraffine waxes, refined, 133-135 m.p.....	lb.	.05 — .051
Paraffine waxes, refined, 135-137 m.p.....	lb.	.051 — .06
Stearic acid, single pressed.....	lb.	.09 — .
Stearic acid, double pressed.....	lb.	.091 — .
Stearic acid, triple pressed.....	lb.	.10 — .101

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$4.95 — .
Rosin E-I.....	280 lb.	5.00 — 5.20
Rosin K-N.....	280 lb.	5.55 — 6.50
Rosin W. G. W. W.....	280 lb.	7.25 — .
Wood rosin, bbl.....	280 lb.	6.25 — .
Spirits of turpentine.....	gal.	.57 — .
Wood turpentine, steam dist.....	gal.	.55 — .
Wood turpentine, dest. dist.....	gal.	.53 — .
Pine tar pitch, bbl.....	200 lb.	. — 7.00
Tar, kiln burned, bbl. (500 lb.).....	bbl.	. — 11.50
Retort tar, bbl.....	500 lb.	. — 11.50
Rosin oil, first run.....	gal.	.33 — .
Rosin oil, second run.....	gal.	.35 — .
Rosin oil, third run.....	gal.	.39 — .
Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	.39 — \$1.80
Pine oil, pure, dest. dist.....	gal.	1.50 — .
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46 — .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35 — .
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75 — .
Pine tar, ref., thin, sp.gr. 1.080-1.060.....	gal.	.35 — .
Turpentine, crude, sp. gr. 0.900-0.970.....	gal.	1.20 — .
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	.35 — .
Pine wood creosote, ref.....	gal.	.52 — .

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.41 — .
70-72 deg., steel bbls. (85 lb.).....	gal.	.39 — .
68-70 deg., steel bbls. (85 lb.).....	gal.	.38 — .
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.30 — .

Crude Rubber

Para-Upriver fine.....	lb.	\$0.16 — .17
Upriver coarse.....	lb.	.09 — .091
Upriver caucho ball.....	lb.	.111 — .12
Plantation—First latex crepe.....	lb.	.141 — .
Ribbed smoked sheets.....	lb.	.12 — .121
Brown crepe, thin, clean.....	lb.	.15 — .
Amber crepe No. 1.....	lb.	.17 — .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.081 — \$0.09
Castor oil, AA, in bbls.....	lb.	.10 — .101
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.141 — .15
Cocanut oil, Ceylon grade, in bbls.....	lb.	.101 — .101
Cocanut oil, Cochinchina grade, in bbls.....	lb.	.11 — .111
Corn oil, crude, in bbls.....	lb.	.071 — .071
Cottonseed oil, cru' (f. o. b. mill).....	lb.	.06 — .061
Cottonseed oil, summer yellow.....	lb.	.071 — .081
Cottonseed oil, winter yellow.....	lb.	.08 — .
Linseed oil, raw, car lots (domestic).....	gal.	.72 — .73
Linseed oil, raw, tank cars (domestic).....	gal.	.66 — .67
Linseed oil, in 5-bbl lots (domestic).....	gal.	.75 — .77

Olive oil, Denatured.....	gal.	\$1.53	—	\$1.45
Palm, Lagos.....	lb.	.06	—	.05
Palm, Niger.....	lb.	.05	—	.05
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.83	—	.90
Rapeseed oil, blown, in bbls.....	gal.	.91	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	—
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05	—	—

FISH

Light pressed menhaden.....	gal.	\$0.42	—	—
Yellow bleached menhaden.....	gal.	.44	—	—
White bleached menhaden.....	gal.	.46	—	—
Blown menhaden.....	gal.	.50	—	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94%, ba. Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	—
Blanc fixe, dry.....	lb.	.04	—	.04
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Cas-ein.....	lb.	.08	—	.10
Chalk, domestic, extra light.....	lb.	.04	—	.05
Chalk, domestic, light.....	lb.	.04	—	.04
Chalk, domestic, heavy.....	lb.	.03	—	.04
Chalk, English, extra light.....	lb.	.04	—	.05
Chalk, English, light.....	lb.	.04	—	.04
Chalk, English, dense.....	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia.....	ret ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	ret ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	ret ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	ret ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	ret ton	15.00	—	25.00
China clay (kaolin), imported, lump.....	ret ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	ret ton	20.00	—	25.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Ind.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06
Graphite, high grade amorphous crude.....	lb.	.02	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	—	—	10.00
Quartz (acid tower) 1 1/2 in., f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	—
Shellac, orange superfine.....	lb.	.70	—	.71
Shellac, A. C. garnet.....	lb.	.53	—	.54
Shellac, T. N.....	lb.	.65	—	.67
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00		
Carborundum refractory brick, 9-in.....	1,000	1250.00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30—32		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33—35		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36—40		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30—35		
Magnesite brick, 9-in. straight.....	net ton	70		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77		
Magnesite brick, soaps and splits.....	net ton	98		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42—45		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46—50		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35—38		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00		
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14 —		
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15 —		
Ferromanganese, 76-80% Mn, domestic.....	gross ton	70.00 —	75.00	
Ferromanganese, 76-80% Mn, English.....	gross ton	70.00 —	75.00	
Spiegelisen, 18-22% Mn.....	gross ton	27.00 —	28.00	
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —	—	
Ferrosilicon, 10-15%.....	gross ton	40.00 —	42.00	
Ferrosilicon, 50%.....	gross ton	68.00 —	70.00	
Ferrosilicon, 75%.....	gross ton	140.00 —	145.00	
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 —	.50	
Ferrouranium, 35-50% of U, per lb. of U content.....	lb.	6.00 —	—	
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00 —	6.50	

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00 — \$10.00		
Chrome ore, Calif concentrates, 50% min. Cr ₂ O ₃	unit	.35 —	.40	
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.35 —	.40	
Coke, foundry, f.o.b. ovens.....	net ton	4.00 —	4.50	
Coke, furnace, f.o.b. ovens.....	net ton	2.75 —	3.00	
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	14.00 —	15.00	
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —	—	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	18.00 —	20.00	
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 —	.01	
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25 —	—	
Manganese ore, chemical (MnO ₂).....	gross ton	55.00 —	60.00	
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 —	.60	
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00 —	—	
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.14 —	.14	
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14 —	.14	
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12 —	.13	
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —	—	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 —	3.00	
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 —	3.25	
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 —	2.50	
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 —	2.50	
Vanadium pentoxide, 99%.....	lb.	12.00 —	14.00	
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00 —	—	
Zircon, washed, iron free.....	lb.	.03 —	—	

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....		12.75	
Aluminum, 98 to 99 per cent.....		28.00@28.5	
Antimony, wholesale lots, Chinese and Japanese.....		4	
Nickel, ordinary (ingot).....		41.00	
Nickel, electrolytic.....		44.00	
Monel metal, spot and blocks.....		35.00	
Monel metal, ingots.....		38.00	
Monel metal, sheet bars.....		40.00	
Tin, 5-ton lots, Straits.....		29.00	
Lead, New York, spot.....		4.40	
Lead, E. St. Louis, spot.....		4.12-4.25	
Zinc, spot, New York.....		4.55	
Zinc, spot, E. St. Louis.....		4.20-4.25	

OTHER METALS

Silver (commercial).....	oz.	\$0.59	
Cadmium.....	lb.	1.00-1.25	
Bismuth (500 lb. lots).....	lb.	1.50@1.55	
Cobalt.....	lb.	4.00	
Magnesium (f.o.b. Philadelphia).....	lb.	1.25	
Platinum.....	oz.	75.00	
Iridium.....	oz.	160.00@180.00	
Palladium.....	oz.	65.00-70.00	
Mercury.....	75 lb.	46.00-47.00	

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....		21.25-21.50	
Copper bottoms.....		28.75-29.00	
Copper rods.....		20.00	
High brass wire.....		17.25	
High brass rods.....		14.25	
Low brass wire.....		18.75	
Low brass rods.....		18.75	
Brazed brass tubing.....		27.50	
Brazed bronze tubing.....		32.25	
Seamless copper tubing.....		22.00	
Seamless high brass tubing.....		20.00	

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.25@ 9.50	9.25	9.50
Copper, heavy and wire.....	8.25@ 8.50	8.50	8.50
Copper, light and bottoms.....	7.25@ 7.75	7.50	7.25
Lead, heavy.....	3.25@ 3.50	3.25	3.25
Lead, tea.....	2.25@ 2.35	2.25	2.25
Brass, heavy.....	4.25@ 4.50	4.50	5.00
Brass, light.....	3.25@ 3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.25@ 4.50	4.25	4.50
Zinc.....	2.00@ 2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.38	\$3.00	\$3.00
8 ft steel bars.....	2.28	2.80	2.80
Soft steel bar shapes.....	2.28	2.90	2.90
Soft steel bands.....	2.50	3.20	3.20
Plates, 1/2 to 1 in. thick.....	2.38	3.00	3.00

*Add 15¢ per 100 lb. for trucking to Jersey City and 10¢ for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

GADSDEN—The Etowah Health Chemical Co. has acquired a local building and will establish a new plant for the manufacture of sweeping compounds and kindred products.

Arkansas

EL DORADO—The El Dorado Refining Co., recently incorporated, has preliminary plans under way for the erection of a new oil refinery. The initial works will comprise two units, each with daily output of about 1,000 bbl. It is proposed to increase this production to about 5,000 bbl. per day at a later date.

SPRINGDALE—The Welch Grape Juice Co., home office, Westfield, N. Y., plans the erection of a large plant here, for the manufacture of grape juice from the product of the vineyards in the Ozark regions of Arkansas. W. A. Ragland, McCall Bldg., Memphis, Tenn., will have direction of this work.

California

SAN FRANCISCO—The W. K. Minerals Co., San Francisco, has acquired the property and business of the Magnesia Products Co., with mineral lands near Patterson, Stanislaus Co. The new owner is said to be planning for extensive operations at the property for the manufacture of magnesia products.

Delaware

WILMINGTON—The blending house at the plant of the United States Flashless Powder Co., Carcroft, near Wilmington, was damaged by fire, caused by an explosion, June 30. An official estimate of the loss has not been made.

WILMINGTON—The Darco Corporation, du Pont Bldg., a subsidiary of the Atlas Powder Co., is said to be selecting a site in Louisiana, in the vicinity of Houma, for the erection of its proposed new carbon-refining works, estimated to cost about \$1,000,000 with machinery. The carbon will be produced from lignite beds in this section. W. J. Webster, head of the Atlas company, is president of the Darco Corporation; H. B. Walmsley is vice-president and secretary.

Illinois

BLUE ISLAND—The American Wire Fabric Co., 136th St. and Western Ave., is taking bids for the erection of a new 1-story galvanizing plant at its works, 47 x 145 ft. A warehouse building will also be constructed and both structures are estimated to cost about \$100,000. Headquarters of the company are at 208 South La Salle St., Chicago.

CHICAGO—LaSalle Extension University is planning the erection of a \$500,000 building at the southeast corner of Michigan Ave. and 41st St. Architect's plans call for a 6-story reinforced-concrete structure with white terra cotta exterior.

Indiana

COLUMBUS—The Indiana Oil Refining Co. will commence the immediate erection of the superstructures for the different buildings at its new refining plant, located on a site about three miles from the city. Foundation work has been completed. The new refinery is estimated to cost about \$500,000 with machinery. O. L. Bartlett is president.

Iowa

DES MOINES—The Keith Furnace Co., West 11th St., manufacturer of furnaces, etc., is taking bids for the erection of a new 1- and 2-story plant at East 26th St. and Bran Ave., estimated to cost about \$250,000 with equipment. Boyd & Moore, 314 Security Bldg., Des Moines, are architects.

Kentucky

ASHLAND—The Mayo Oil Service Co., 11th and Front Sts., recently incorporated, is planning for the erection of a new oil refinery on a local site. John C. C. Mayo is president and treasurer.

Louisiana

SHREVEPORT—The Henderson Cotton Oil Co. is reported to be planning for the rebuilding of the portion of its plant, destroyed by fire, June 22, with loss estimated at about \$300,000, including equipment.

Maryland

BALTIMORE—The Gwynns Falls Paper Co., 517 Calvert Bldg., has completed plans for its proposed new plant at Gwynns Falls and will begin construction during the present month. The plant will be devoted to the manufacture of high-grade paper board products and will be equipped for a maximum daily output of about 85 tons of material. It will give employment to about 150 operatives and is estimated to cost in excess of \$500,000. Joseph H. Wallace & Co., 5 Beekman St., New York, are engineers. Joseph G. Mayo, formerly connected with the Spanish River Pulp & Paper Mills, Canada, will be manager at the plant. George W. Davis is head.

BALTIMORE—The Holdtite Rubber Co., 919 Baltimore St., has foundations under way for the erection of its proposed new plant at Warner and Ostend Sts., for the manufacture of rubber specialties. It will be 1-story, 50 x 125 ft., and estimated to cost about \$25,000.

Michigan

DETROIT—The Solvay Process Co., Syracuse, N. Y., has arranged for the curtailment of operations at its local plant for an indefinite period.

Missouri

ST. LOUIS—The Wrought Iron Range Co., 5661 Natural Bridge Ave., has filed plans for the erection of its proposed new 2-story plant addition, 146 x 220 ft., estimated to cost about \$75,000. The Murch Bros. Construction Co., Railway Exchange Bldg., is contractor.

KANSAS CITY—The new chemical laboratory now being erected at 729 Holmes St. by A. W. Estabrook is nearing completion and will be equipped and placed in operation at an early date. The structure is 2-story and basement, 40 x 60 ft.

New Jersey

LAKEHURST—The War Department is arranging for the abandonment of the property occupied here by the chemical warfare plant, and plans are being perfected for the removal of this work to the Edgewood Arsenal, Maryland. The local site is about 18,000 acres and will be placed on the market.

JERSEY CITY—Colgate & Co., 105 Hudson St., are said to have plans under way for the remodeling and improving of the state reformatory buildings at Jeffersonville, Ind., recently acquired for the establishment of a new branch plant for the manufacture of soaps, powders and kindred specialties. With new structures, the work is estimated to cost about \$500,000.

MILLVILLE—The Whitall Tatum Co. has blown out two of its local glass manufacturing plants for the summer season. The glass works at South Millville will be continued in service for several weeks.

New York

SYRACUSE—The Onondaga Pottery Co., 1855 West Fayette St., manufacturer of earthenware products, is completing plans for the erection of a new plant on Court St., estimated to cost about \$500,000 with machinery. No date has as yet been set for asking bids, or time decided for erection of the structure. Guy L. Noble, Union Bldg., is engineer.

MELLENVILLE—The Columbia Valley Paper Co., 44 Howard St., Albany, N. Y.,

has completed plans for the erection of a new paper mill at Mellenville. Construction will be commenced at an early date. F. B. Oldham is president.

ALBANY—The Hires-Turner Glass Co., 30th and Walnut Sts., Philadelphia, Pa., has awarded a contract to the Panzeri-Hogan Co., 90 State St., Albany, for the erection of its proposed new local plant on Tivoli St., comprising main glass manufacturing building and boiler plant, estimated to cost about \$100,000.

North Carolina

MIDVALE—The Canton Brick & Fireproofing Co., Canton, N. C., is planning for the construction of a new plant at Midvale for the manufacture of brick and other burned clay products.

Ohio

STEUBENVILLE—The Wheeling Steel Corporation, Wheeling, W. Va., has preliminary plans under way for extensions and improvements at its La Belle Iron Works, Steubenville, to cost in excess of \$2,000,000. It is said that the company proposes to develop this plant as its leading producing unit.

SANDUSKY—The Hord Color Products Co. has completed the erection of its new plant, to replace the works destroyed by fire last fall, and operations have been started.

Oklahoma

ENID—The Garfield Refining Co. has acquired the properties of the Oil State Petroleum Co., the Healdton Oil Co. and the Penn-Oklahoma Oil Co., with total holdings estimated at \$4,000,000 in valuation. The new owner plans for extensive development and operation.

Ontario

HAILEYBURY—Fire, June 27, destroyed a portion of the plant of the Haileybury Brick & Tile Co., with loss estimated at about \$22,000.

Texas

ORANGE—The Reclamation Oil Co., recently incorporated with a capital of \$2,000,000, has plans under way for the erection of a new oil-refining plant on local site. E. J. Pike is president.

CORPUS CHRISTI—The Isthmus Co. is planning for the erection of a new distillation plant in connection with a local gas works, estimated to cost close to \$150,000.

SAN ANTONIO—The Taft Packing Co. is planning for extensions in its local cottonseed oil plant, to increase the daily production to about two carloads of material per day. Plans are under way for the construction of a new fertilizer manufacturing plant at Taft, Tex. Herbert S. Greene, San Antonio, is architect. V. H. Fetick is manager.

FORT WORTH—The White Eagle Refining Co., Augusta, Kan., is planning for extensions and improvements in its local oil refinery.

MARSHALL—The Industrial Gas Co. has awarded a contract to the Hope Engineering & Supply Co., Mt. Vernon, O., for the construction of a new local gasoline plant. With subsidiary works, the new plant is estimated to cost about \$350,000. W. H. Sedberry is engineer.

BROWNWOOD—The Blue Ribbon Refineries, Box 295, is planning for the installation of new filters, driers and other equipment at its oil works. P. J. Baney is president and manager.

Virginia

ROANOKE—The Viscose Co. of America, Marcus Hook, Pa., manufacturer of artificial silk under a chemical process, has plans under way for the erection of an addition to its plant at Roanoke to double the present capacity. The extension, with machinery, will cost close to \$1,000,000. The Ballinger Co., 105 South 12th St., Philadelphia, Pa., is architect.

PORTSMOUTH—The Texas Co., Texas Bldg., Houston, Tex., operating oil refineries, has acquired property, 100 x 600 ft., at Portsmouth, for the erection of a new plant. Preliminary plans are said to be under way.

West Virginia

WHITE SULPHUR SPRINGS—The Cosmopolite Mfg. Co., recently incorporated with a capital of \$25,000, will operate a local plant for the manufacture of spark plugs. G. P. Brown is president and W. M. Sullivan, vice-president.

Wisconsin

MILWAUKEE — The American Metal Products Co., 671 Kinnickinnic Ave., has awarded a contract to the Worden-Allen Co., Washington Rd., for the erection of a new 1-story foundry addition on Bernham Rd. A machine shop will also be constructed.

Capital Increases, etc.

THE PYRAMID BRICK CO., 1007 Scofield Bldg., Cleveland, O., has filed notice of increase in capital from \$300,000 to \$400,000.

THE BLANCHARD OXYGEN CO., Esopus, N. Y., has filed notice of dissolution under state laws.

A petition in bankruptcy has been filed against the YARLEY CHEMICAL CORP., 50 Union Sq., New York City, by a number of creditors.

THE HANNA FURNACE CO., Leader Bldg., Cleveland, O., producer of pig iron, has arranged for a bond issue of \$4,000,000 for general financing, operations, etc. The company is affiliated with M. A. Hanna & Co., Inc., H. M. Hanna, Jr., is president.

THE WILLIAM E. DEE CLAY MFG. CO., 30 North La Salle St., Chicago, Ill., has filed notice of increase in capital from \$100,000 to \$600,000.

THE DIBBLE COLOR CO., Detroit, Mich., manufacturer of colors, etc., has filed notice of increase in capital from \$50,000 to \$100,000.

THE OCTAGON DROP FORGE CO., 2428 Lowe Avenue, Chicago, Ill., has filed notice of increase in capital from \$30,000 to \$105,000.

THE PORT HURON SALT CO., Port Huron, Mich., has filed notice of decrease in capitalization from \$235,000 to \$10,000.

THE AMERICAN MARINE PAINT CO., 8 Bridge St., New York City, has filed notice of increase in capital from \$100,000 to \$250,000.

THE FIVE POINT CHEMICAL CO., Richmond, Va., recently incorporated, has filed notice of increase in capital from \$25,000 to \$150,000. John B. Brooks is president.

New Companies

THE BIXIE CORP., New York City, has been incorporated with a capital of \$55,000 to manufacture soaps, oils and kindred products. The incorporators are H. N. Henry, R. S. Childs and L. McManus. The company is represented by McKercher & Link, 17 Battery Pl.

THE RUBBER PROINATE CORP., Richmond, Va., has been incorporated with a capital of \$15,000 to manufacture rubber products. A. M. Rubenstein is president, and C. V. Blackburn secretary.

THE MERCHANTS LEATHER GOODS CO., INC., Providence, R. I., has been incorporated with a capital of \$50,000, to manufacture leather products. The incorporators are Julius Abrams, Charles M. Robinson and Harry Lapen, 65 Moore St.

THE GEORGE F. CROAK FOUNDRY CO., Boston, Mass., has been incorporated with a capital of \$25,000, to manufacture iron, steel and other metal castings. The incorporators are George F. Croak, Athol, Mass., who has been elected president and treasurer; Winthrop Q. Nottage and Gerald M. Croak.

THE SIGNAL PETROLEUM CORP., Long Beach, Cal., has been incorporated with a capital of \$300,000, to manufacture petroleum products. The incorporators are J. C. Rogers, E. S. Dobbin and W. B. Murphy. The company is represented by Desmond & Larzelere, Long Beach.

THE CENTURY MANUFACTURING CO., Buffalo, N. Y., has been incorporated with a capital of \$100,000, to manufacture chemicals and paints. The incorporators are R. A. Maltby, W. N. Carlisle and F. F. Everingham. The company is represented by F. W. Thomas, Ellicott Sq., Buffalo.

THE FRANK MASON CHEMICAL CO., 737 West Madison St., Chicago, Ill., has been incorporated with a capital of \$20,000, to manufacture chemical products. The incorporators are Frank Mason, George E. Krueger and Elmer T. Good.

THE MILLS BROS. CO., Gloversville, N. Y., has been incorporated with a capital of \$200,000, to manufacture leather products. The incorporators are W. E. Mills, D. McEwen and R. E. Toye. The company is represented by F. L. Carroll, Johnstown, N. Y.

THE STATE LINE OIL CO., 28 East Jackson Blvd., Chicago, Ill., has been incorporated with a capital of \$82,500, to manufacture refined oil products. The incorporators are Paul Herbert, E. J. Alexander and B. M. Schlichting.

THE J. F. MOSSER CORP., Boston, Mass., has been incorporated with a capital of \$100,000, to manufacture and deal in tanning extracts and kindred products. J. F. Mosser, 176 Federal St., is president and treasurer; Joseph N. Welch and G. L. Willson are directors.

THE FEDERAL CHEMICAL CORP., Hyattsville, Md., has been incorporated with a capital of \$100,000, to manufacture chemicals and byproducts. The incorporators are William A. Mills, J. L. Humphrey and E. G. Bucklin, Hyattsville.

THE HAMLIN OIL CO., Buffalo, N. Y., has been incorporated with a capital of \$60,000, to manufacture oil products. The incorporators are C. P. Lake and A. Wiborg. The company is represented by W. H. Warhus, Ellicott Sq., Buffalo.

THE COAL GROVE BRICK & TILE CO., Huntington, W. Va., has been incorporated with a capital of \$100,000, to manufacture brick, tile and other burned clay products. The incorporators are T. E. Jeffries, Huntington; and J. W. Lowry, Ironton, O.

THE LANTAGNE LABORATORY, INC., Lowell, Mass., has been incorporated with a capital of \$40,000, to manufacture chemicals, drugs, etc. Joseph T. Lantagne is president; and William A. O'Malley, Draught, Mass., treasurer.

THE MARINE PETROLEUM CO., Chicago, Ill., has been incorporated with a capital of \$1,000,000, to manufacture oil products. The incorporators are L. E. Gowan and A. E. Manheimer, 10 South LaSalle St.

THE CLARK RUBBER SYNDICATE, Rochester, N. Y., has been incorporated with a capital of \$50,000 to manufacture rubber products. The incorporators are F. P. Dunham, I. D. Allen and S. A. Millington. The company is represented by G. V. Holton, attorney, Rochester.

THE S-O-BELL SOAP CO., Kittery, Me., has been incorporated with a capital of \$250,000, to manufacture soap and kindred products. Horace Mitchell is president and D. E. Phillips treasurer, both of Kittery.

THE MONROE OIL & REFINING CORP., Fort Worth, Tex., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are H. H. Harolson and V. S. Monroe, Fort Worth; and C. W. Perry, Polytechnic, Tex.

THE TENNESSEE METAL TIE CO., Camden, Tenn., has been incorporated with a capital of \$100,000 to manufacture metal ties and other metallic products. The incorporators are Ira L. Presson, J. F. Lindsey and J. M. Holladay, Camden.

THE WOFFORD OIL CO., Birmingham, Ala., has been incorporated with a capital of \$10,000,000 under Delaware laws to manufacture oils and greases. The incorporators are George T. Wofford, J. Gregory Johnston and C. B. Deming, Birmingham.

THE CO-OPERATIVE PAPER BOX CO., INC., 3502 Cottage Ave., Baltimore, Md., has been incorporated with a capital of \$50,000 to manufacture paper boxes and containers. The incorporators are Benjamin F. Garrett, Edward W. Williams and Alfred W. Watson.

THE GUY LEE LEATHER CO., Philadelphia, Pa., has been incorporated with a capital of \$15,000 to manufacture leather products. Guy Lee, Woodbury, N. J., is treasurer.

THE PHOSPHATE PRODUCTS CO., Mount Pleasant, Tenn., has been incorporated with a capital of \$250,000 to manufacture phosphates, fertilizers, etc. The incorporators are N. B. Stewart and E. E. Fisher, Mount Pleasant.

THE WYOMING DYESTUFF & CHEMICAL CO., Scranton, Pa., has been organized to manufacture sulphur colors, chemicals, etc. A. H. Ney is president and J. F. Higgins secretary-treasurer, both of Scranton.

W. C. DAMBACH, INC., Buffalo, N. Y., has been incorporated with a capital of \$40,000 to manufacture chemicals and chemical byproducts. The incorporators are W. G. Dambach, F. D. Perrin and J. J. Stein. The company is represented by Stein & Barber, Brisbane Bldg., Buffalo.

THE AURORE OIL CO., Syracuse, N. Y., has been incorporated with a capital of \$50,000 to manufacture oil products. The incorporators are A. L. and J. A. McAdam, and J. Bundy. The company is represented by Wells, Nelly & Nichols, attorneys, Syracuse.

THE PHE-DER-MOL CO., INC., Reading, Pa., has been incorporated with a capital of \$100,000 to manufacture special compounds, chemicals, etc. The incorporators are E. E. Clement, A. P. Utt, Reading; and S. B. Wentzel, Pottstown, Pa.

T. VAN AMRINGE & SON, INC., New York City, has been incorporated with a capital of \$60,000 to manufacture petroleum products. The incorporators are I. Kemp, W. R. Halsey and A. Y. Van Amringe. The company is represented by B. C. Meighan, 120 B'way.

THE BREWSTER DRUG CO., New York City, has been incorporated with a capital of \$25,000 to manufacture chemicals, chemical byproducts, drugs, etc. The incorporators are L. Walcott, C. Forbes and J. Rooney. The company is represented by C. A. Winter, 507 Fifth Ave.

THE MONTVILLE PAPER CO., Palmertown Road, Montville, Conn., recently incorporated with a capital of \$50,000 to manufacture paper products, has been organized with E. H. Backes, Wallingford, Conn., as president; C. E. Dunn, Wallingford, secretary, and R. C. Burchard, Montville, treasurer.

THE PERCY OIL CO., Clarksburg, W. Va., has been incorporated with a capital of \$500,000 to manufacture oil products. The incorporators are D. J. Carter and J. W. Woodell.

THE HOME RIDGE OIL CO., 1404 Harris Trust Bldg., Chicago, Ill., has been incorporated with a capital of \$10,000 to manufacture oils, greases, etc. The incorporators are R. O. Farrell, E. F. Brubaker and J. A. Langlands.

THE LUMINO MFG. CO., New York City, has been incorporated with a nominal capital of \$5,000 to manufacture soaps, polishes, etc. The incorporators are A. Podel, W. H. England and M. Katz. The company is represented by E. M. Garbe, 13 Park Row.

THE CORNWALL CHEMICAL CORP., New York City, has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are N. Criss, I. Mark and R. Brown. The company is represented by L. B. Bouldin, 110 West 40th St.

Industrial Notes

THE LYONS FAIR will hold its autumn meeting Oct. 1 to 15, 1921, in Lyons, France. This fair is for the promotion of international trade, and American manufacturers are extended a hearty welcome to exhibit their products. The fair exhibits all articles manufactured, from clothing to freight locomotives, and include in our field products for general engineering, industrial buildings, india rubber goods, agricultural products, agricultural machinery, etc. Information can be obtained by addressing Emile Garden, 150 Nassau St., New York City.

PAUL H. HSU, a graduate of the Massachusetts Institute of Technology and at one time employed as research chemist with the Larkin Co., Buffalo, N. Y., and also with the chemical division of the Procter & Gamble Co., Cincinnati, O., is on his way to China, where he expects to be engaged in consulting work and marketing of chemical machinery and materials. He requests that manufacturers send him catalogs, blueprints, etc. He can be reached care of Government Institute of Technology, 18 Sic-cawel Road, Shanghai, China.

THE AMERICAN CHEMICAL & SUGAR MACHINERY CO., Philadelphia, announces the Fred W. Kolb, its Pacific Coast representative, has associated with him M. Gillespie and that the business will now be handled by the firm of Kolb & Gillespie, 576 Monadnock Bldg., San Francisco.

ARNOLD, HOFFMAN & CO., 61 B'way, New York City, announce that they are now sole selling agents for the Belle Alkali Co., of Belle, W. Va., manufacturer of pure liquid chlorine, in 100-lb. and 150-lb. cylinders and 2,000-lb. tanks, and electrolytic caustic soda 76 per cent, solid and flake, in large and small drums.

THE WESTINGHOUSE ELECTRIC & MFG. CO. has opened an interplant wireless communication service between the East Pittsburgh plant and the Cleveland foundry. Besides the Cleveland and East Pittsburgh factories, the Springfield, Mass., works and the Newark, N. J., works are being equipped with stations for the transacting of company business.

THE COMBUSTION ENGINEERING CORP., New York City, announces that the sales organization in Philadelphia has been increased and a new service department inaugurated, which has necessitated getting new office space. Its new location is on the tenth floor of the Finance Bldg. The territory is under the management of W. C. Stripe.

THE ARBESTOS STEEL PLATE & SHEATHING CO. has leased warehouse space in the North Pier Terminal Warehouse, Chicago, with suitable offices at 319 North Wells St., to handle business in that territory.

THE ELECTRIC FURNACE CONSTRUCTION CO., Philadelphia, Pa., announces that the Compania Electro Metallurgia Brazillera and the Batcheller-McConnell Co., New York City, have recently acquired from Frank

Hodson, president of the company, and his Swedish associates the exclusive rights and licenses for Brazil for the Gronwall type "Electrometall" electric shaft smelting furnace. Two large furnaces, each of 3,000-kw. capacity, are at present being installed by the Brazilian company.

THE ARMSTRONG CORK CO., Pittsburgh, Pa., announces the following branch office changes: The Armstrong Cork & Insulation Co., Cincinnati, O., moved from 1608 First National Bank Bldg. to 1015 B'way. P. E. Thomas is manager. The Armstrong Cork & Insulation Co., Boston, Mass., moved from 84 North St. to 14 Columbia St. F. W. Robinson is manager, succeeding A. L. Dorr, who recently resigned. The Kansas City, Mo., office address is 529 Lee Bldg., this being only a change in name of the building.

THE FRANKLIN INSTITUTE OF THE STATE OF PENNSYLVANIA, acting through its committee on science and the arts, investigating the jet entraining apparatus of the Surface Combustion Co., New York City, has awarded to the inventor, W. Barton Eddison, the Edward Longstreth Medal of Merit.

H. E. LABOUR, who was formerly connected with the Chemical Equipment Co., has organized a new corporation under the name of the LaBour Co., with headquarters at Michigan City, Ind. This concern will be engaged in the manufacturing and sales business. One of the first units put on the market will be a new type of centrifugal pump invented by Mr. LaBour.

H. G. CARRELL has been appointed sales manager of Wing & Evans, New York City, the sales agents for the Solvay Process Co.

THE METAL & THERMIT CORP., New York City, has recently transferred William Aldrich from the Southern territory to the Western territory. He will travel extensively through California, Oregon, Washington, Idaho, Nevada, Utah and Arizona and will make his headquarters at the new South San Francisco office. William H. Moore, who until recently was assigned to the Chicago territory, now has charge of the Southern territory. This company also announces that in order to handle more satisfactorily its detinning business in the West it has constructed and will shortly place in operation in South San Francisco, Cal., a large new plant for the production of detinned billets, in addition to the detinning plants already operated at Chrome, N. J., and East Chicago, Ind. This new plant has been equipped with a large welding shop containing equipment and facilities for undertaking repairing by the Thermit process.

THE TERMINAL ENGINEERING CO., New York City, has added to its staff J. F. McGonigal, formerly of the Foamite Co., and J. H. Potter, a graduate of New York University. M. E. Lyle, for many years with the Columbia Graphophone Co., has been elected a vice-president and is directly responsible for new business, and M. E. Peck has been elected secretary and assistant treasurer.

THE MAGNETIC CO. moved on June 20 into its new plant at 275 23rd Ave., Milwaukee, Wis. The new plant trebles the floor space in the former plant, providing up-to-date facilities for the continued production of its line of magnetic separators.

THE LINK-BELT CO., Chicago, has acquired all of the capital stock of the H. W. Caldwell & Son Co., and Frank C. Caldwell has been elected a director of the Link-Belt Co. The Link-Belt Co. has thus added two new lines, helioid conveyors and power transmission machinery, to its present line of manufacture. The H. W. Caldwell & Son Co.'s plant will continue to operate under separate corporate existence and under its present name.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., has opened a branch office in Cleveland in the Reliance Bank Bldg., to take care of that district.

PAWLING & HARNISCHFEGGER CO., Milwaukee, Wis., announces that the San Francisco office has been moved from the Monadnock Bldg. to 32 Beale St. At this new address the company maintains a complete service station warehouse and display room for cranes and hoists, machine tools and excavating machinery. R. M. Taylor is district manager.

SAVELL & FROST, of Niagara Falls, N. Y., announce that anhydrous aluminum chloride of high purity is now being produced in commercial quantities at their plant by a process which will make this chemical available for a number of uses requiring a better and cheaper material than has been obtainable heretofore.

THE DOMINION OXYGEN CO., LTD., is breaking ground for a new quarter million oxygen plant at Montreal, which will double the company's present capacity. The build-

ing will be 100 ft. x 100 ft. and will be substantially a duplicate of the company's Toronto plant, which until now has supplied oxygen to Canadian industrial users through five district distributing stations. The Montreal plant will be the second of five producing plants projected at the time the company was organized last year.

Manufacturers' Catalogs

THE DRAPER MFG. CO., Cleveland, O., has issued a very attractive catalog, No. 7, entitled "Steel Barrels for All Purposes." The first section illustrates and describes the various types of steel barrels and gives their capacity, dimensions, cubic space, weight and average number to car load. The Interstate Commerce Commission tests to which these barrels were subjected are explained. Pages 103 to 160 contain useful tables not ordinarily found in a catalog of this type. This feature makes the booklet of unique value.

THE PAWLING & HARNISCHFEGGER CO., Milwaukee, Wis., has issued two new leaflets, on shovel attachment for P. & H. types 205 and 206 excavator-crane.

THE STEERE ENGINEERING CO., Detroit, Mich., has issued a pamphlet on "The Intensive Scrubber for Recovery of Ammonia from Coal Gas."

THE GRISCOMB-RUSSELL CO., New York City, has issued Bulletin 1140, on Stratton team Separator, and a pamphlet on G-R expansion joint.

THE CHICAGO PNEUMATIC TOOL CO., New York City, has issued Bulletin 648, which describes little giant geared air hoists, motors and winches. This bulletin shows application views of this hoist in various industries and for innumerable operations, such as handling steel plates in storage yards, serving sheet steel to cutting machine at large boiler shops, etc. Copies will be sent to those interested, upon request.

THE CAROLINA, CLINCHFIELD & OHIO RY., Johnson City, Tenn., has issued a booklet on "The Mineral Resources of the Clinchfield Territory."

CARRIER AIR CONDITIONS CO. OF AMERICA, Buffalo, N. Y., has issued Catalog 480, on "Carrier Air Washers and Humidifiers," which is well illustrated.

THE PACIFIC TANK & PIPE CO., San Francisco, Cal., have issued Catalog 14 on "Pacific Wood Stave Pipe." This attractive 128-page catalog is the first pipe catalog this company has issued for a number of years and is the result of study of wood pipe for the past thirty years. Illustrations and description of some installations are given of Pacific wood-stave pipe and the various kinds of joints, fittings, valves, etc., that are used of both types—viz., "Continuous-stave" and "machine-banded." Tables have been inserted based on formulas resulting from an extensive series of investigations made by the U. S. Government. These are conceded to be the latest word on the subject of flow water through this kind of pipe. In the final section is a description of several Pacific products closely allied to the manufacture of wood-stave pipe.

THE PETROLEUM RECTIFYING CO. OF CALIFORNIA has issued a catalog on the Electrical Process for the Dehydration of Crude Oil Emulsions.

THE SULLIVAN MACHINERY CO., Chicago, Ill., has just issued Bulletin 78-A, which describes and illustrates dry vacuum pumps, single cylinder, steam and belt driven. These pumps are equipped with improved wafer type plate valves for both intake and discharge openings. The Sullivan Turbinal Hoist is another new product, which is described in Bulletin 76. These hoists are used in mining of coal and metal and in many phases of industrial work.

THE WHEELER CONDENSER & ENGINEERING CO., Carteret, N. J., announces the publication of the 1921 edition of its "Steam Tables for Condenser Work." This is the sixth edition. The tables are in book form, pocket size. The properties of saturated steam are tabulated from 29.8 in. vacuum to atmospheric pressure in increments of tenths of an inch referred to a 30-in. barometer. The values were especially calculated for this book by Prof. Marks. As it is customary in vacuum work to read vacuum in inches of mercury, this is superior to the old method of giving absolute pressures in lb. per sq. in. Above atmospheric pressure the increments are in pounds gage. The book explains how measurements are made by means of the mercury column and barometer, and gives

constants and tables for making corrections. Corrections for the thermal expansion of mercury, for the relative expansion of mercury and brass scale, and other corrections are included.

THE PFAUDLER CO., Rochester, N. Y., has issued a new booklet on "Glass-Lined Steel Equipment," such as mixing tanks, stills, pots, crystallizing pans, etc. The company's research laboratory is featured as being the power behind the sales organization.

New Publications

BOOKS

SWEET'S ENGINEERING CATALOG, Seventh Annual Edition. Compiled, edited and published by Sweet's Catalog Service, Inc., New York. Cloth, 1251 pages; illustrated and indexed.

Sweet's Engineering is a catalog filing system which contains the separate catalogs of about seven hundred manufacturers. The field it covers is that of engineering and power plant equipment, or, to quote more definitely from the preface, it lists "Materials, equipment and supplies relating to the practical construction, equipment and maintenance of all projects of an industrial or engineering nature." In other words, the products it describes range from drawing boards to dynamos and from lighting receptacles to locomotive cranes.

The seventh edition of Sweet's Engineering, which has just appeared, marks an improvement in many ways over those which preceded it. The products index, for example, has been revised and simplified, so that it is now much easier to locate any desired information. This information, in turn, has been arranged in a more logical fashion. Even the appearance of the book has been improved by a better balance of cut and by the use of a better quality of paper. The new edition is smaller, lighter and easier to handle, although the number of pages in the volume and the number of firms represented show a marked increase.

TEXT BOOKS ON THE MANUFACTURE OF PULP AND PAPER. Five volumes. Price, \$5 per volume. Published by the Joint Committee on Vocational Education of the Pulp and Paper Industry, Thomas J. Keenan, secretary of T.A.P.P.I., 542 Fifth Ave., New York City.

Volumes I and II of this set deal with arithmetical calculations, elementary mathematics, drawings, etc. Volumes III, IV and V, to be issued shortly, will deal with pulp woods and their preparation, manufacture of pulp, analytical methods and all aspects of paper manufacture. In the selection of classroom problems bearing on the principles and practice of pulp and paper manufacture these books represent a high standard in text book publishing.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.